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FAO Aquaculture Newsletter

In this month's issue

INVITED EDITORIAL

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Feeding Global Aquaculture Growth

In 2015, global aquaculture production reached 106 million tonnes, 76.6 million tonnes of aquatic animals and 29.4 million tonnes of aquatic plants, growing at an average annual rate of 6.6 percent since 1995. This positive trend, although now slowing, is projected to continue; consequently, the aquaculture sector is expected to play a significantly greater role in contributing to food security, poverty alleviation and economic development of the poor. However, the global population is increasing and, in order to maintain at least the current level of per-capita consumption of aquatic foods (19.7 kg in 2013, FAO, 2016), the world will require an additional 23 million tonnes thereof by 2020. This additional supply will have to come from aquaculture. Meeting the future demand for food from aquaculture will largely depend on the availability of quality feeds at affordable prices in the requisite quantities. Aquafeed accounts for about 50-80 percent of aquaculture production cost and therefore its use has to be carefully considered and managed.

During the period 1995-2015, production from feed-dependent aquaculture increased over fourfold from 12.2 to 50.7 million tonnes, largely through intensification of production methods. The use of aquatic species/species groups such as tilapias, carps, shrimp and salmonids with established aquaculture technologies provided firm market opportunities for increasing production and driving production efficiency. In 2015, about 50.7 million tonnes of farmed fish was dependent upon the supply of external nutrient inputs provided in the form of fresh feed ingredients, farm-made feeds or commercially manufactured feeds. It is estimated that in 2015, 47.7 million tonnes of industrial aquafeed was produced excluding the commercial feed used by Indian major carp, which are increasingly fed with commercial feed along with supplementary feeds.

In 2013, global production of fishmeal and fish oil were 4.92 and 0.91 million tonnes, respectively and within the animal husbandry subsectors, aquaculture is now the largest user of fishmeal and fish oil. These two products are primarily used for the production of industrial aquafeed; it is estimated that about 10 percent of global fishmeal used for aquaculture, goes for production of farm-made aquafeed. Although the use of fishmeal and fish oil in aquafeeds is more prevalent for higher trophic level finfishes and crustaceans (marine shrimps, marine fishes, salmons, freshwater crustaceans, trouts, eels, etc.), low-trophic level finfish species/species groups (carps, tilapias, catfishes, milkfish, etc.) are also fed with these products. Over recent decades, significant efforts have been made by the aquaculture industry to reduce the levels of inclusion of fishmeal and fish oil. The reduction of the feed conversion ratio (FCR) has played an important role in more efficient use of these inputs, which

COVER PHOTOS: LEFT PHOTO: ©A. STANKUS, RIGHT PHOTOS: ©L. DABBADIE

has largely been achieved through improved feed management. There has been a gradual reduction of fishmeal use in aquafeeds since 2006.

Although the discussion on the availability and use of aquafeed ingredients often focuses on fishmeal and fish oil resources (including low-value fish/trash fish), considering past trends and current predictions, sustainability of the aquaculture sector is more likely to be closely linked with the sustained supply of terrestrial animal and plant proteins, oils and carbohydrate sources for aquafeeds. The aquaculture sector should therefore strive to ensure sustainable supplies of terrestrial and plant feed ingredients.

Furthermore, the aquaculture sector, primarily in Asia and sub-Saharan Africa, is constrained by various other factors, including inadequate access to finance, a lack of technical innovation, an absence of feed formulation and processing knowledge and the use of inappropriate feed management practices. Other constraints to feed supply, quality and use in those countries are poor regulatory control and a lack of standards throughout the aquafeed value chain. Appropriate aquafeed policy, regulatory frameworks, and feed standards need to be developed in those countries where they are lacking, and institutional capacity needs strengthening in agencies responsible for aquaculture management, monitoring and compliance. Other issues that need to be addressed are training and the dissemination of information to farmers, particularly small-scale farmers with limited access to the latest technological and management developments.

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SEE ALSO

FAO. 2016. The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome. 200 pp. **www.fao.org/3/a-i5555e.pdf**

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GLOBAL AQUACULTURE UPDATES

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An Overview of Recently Published Global Aquaculture Statistics

With Botswana included as the newest aquaculture producer country, the FAO Global Aquaculture Production Statistics Dataset for 1950-2015 released in March 2017 has registered a total of 201 currently existing countries and territories with aquaculture production statistical data. The new dataset now contains records of 591 aquatic species and species groups ever farmed in inland freshwater, inland saline water, coastal brackish water and marine water.

Not unexpectedly, world aquaculture production continued its growth in 2015. The newly released FAO aquaculture statistics has recorded another all-time high world aquaculture production of 106 million tonnes in live weight in the year 2015, with a total estimated first-sale value of US$163 billion (Table 1). This total production comprised *farmed aquatic animals, aquatic plants and non-food products* (pearls and shells).

The growth of world aquaculture production of aquatic animals in the first 15 years in the new millennium has gradually slowed down and the 2001-2015 average annual growth rate was 5.9%, which is significantly lower than the double digit growth percentage rate seen in the 1980s and the 1990s. At continent level, African aquaculture growth during 2001-2015 averaged at 10.4%, followed by Asia (6%) and Americas (5.7%). In Oceania and Europe aquaculture growth were only 2.9% and 2.5%, respectively, in the last 15 years.

In 2015 world food fish aquaculture increased by 4%, the lowest annual growth rate in the past few decades. Americas and Oceania experienced negative growth in 2015 (Table 2).

By production volume, the sub-sector of aquaculture of aquatic animals has been dominated by finfish farming, which represents the major aquaculture product in many countries (Figure 1). The contribution of finfish has been maintained between 63-68% in the last two decades. Molluscs farming, which used to count for about 30% of the total food fish farming production around the year 2000, has gradually declined to 21% in 2015. In contrast, crustacean farming improved its share from less than 5% before 2000 to close to 10% in the past decade. Aquatic plants farming counted for 27.7% in 2015 in the total production volume when aquatic plants and animals are combined.

The composition of major groups of species of farmed aquatic animals vary greatly across the world. Finfish farming is the most

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important type of aquaculture operation in volume terms on all continents. In 2015 finfish farming counted for 67.8% of total aquaculture output of aquatic animals (Table 3).

Aquaculture has made steadily increasing contribution to the world fish supply. Within 15 years in the new millennium, the aquaculture contribution to the world production of aquatic animals (captured and farmed combined) has increased from 25.7% in 2000 to 45.3% in 2015 (Figure 2).

To the production of aquatic animals from marine and brackish water, aquaculture (including mariculture and coastal

Table 1 – World aquaculture production in 2015

	Quantity (live weight)	Value (first sale)
Food fish*	76.6 million tonnes	US$157.9 billion
Aquatic plants**	29.4 million tonnes	US$4.8 billion
Non-food products	41.1 thousand tonnes	US$208.2 million
Total	**106 million tonnes**	**US$163 billion**

* Food fish includes finfish, crustaceans, molluscs and other aquatic animals such as sea urchins and sea cucumbers, frogs and aquatic turtles, etc. Farmed crocodile and alligators are excluded.

** Aquatic plants include mostly seaweeds, plus some microalgae.

Table 2 – World aquaculture production of food fish by continent (live weight in thousand tonnes)

	2000	2002	2004	2006	2008	2010	2012	2014	2015	2015 share in world total	2015 growth
Africa	400	453	559	755	942	1 286	1 484	1 711	1 772	2.3%	3.6%
Americas	1 423	1 801	2 143	2 369	2 470	2 514	2 990	3 347	3 273	4.3%	-2.2%
Asia	28 422	32 361	36 895	41 780	47 001	52 452	58 956	65 506	68 393	89.3%	4.4%
Europe	2 051	2 043	2 173	2 193	2 327	2 523	2 827	2 929	2 975	3.9%	1.6%
Oceania	121	128	139	161	175	190	186	189	186	0.2%	-1.5%
World	**32 418**	**36 786**	**41 909**	**47 257**	**52 915**	**58 964**	**66 443**	**73 681**	**76 600**	**100%**	**4.0%**

Figure 1 – World aquaculture production of farmed aquatic animals and plants (1990-2015)

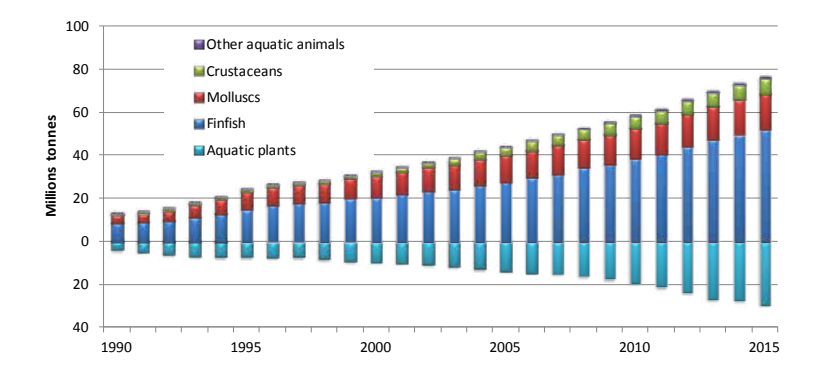


Table 3 – 2015 world aquaculture production by continent by main species group (thousand tonnes in live weight)

INLAND AQUACULTURE	Africa	Americas	Asia	Europe	Oceania	WORLD
1. Finfish	1 749 712	1 017 534	41 849 837	475 253	5 013	**45 097 349**
2. Crustacea	17	63 954	2 792 441	51	162	**2 856 625**
3. Molluscs		0	283 744			**283 744**
4. Other aquatic animals		531	521 106	0		**521 637**
Sub-total	**1 749 729**	**1 082 019**	**45 447 128**	**475 304**	**5 175**	**48 759 355**
MARINE AND COASTAL AQUACULTURE	**Africa**	**Americas**	**Asia**	**Europe**	**Oceania**	**WORLD**
1. Finfish	15 152	1 003 191	3 855 936	1 863 068	72 775	**6 810 121**
2. Crustacea	3 716	722 869	3 761 188	259	6 693	**4 494 725**
3. Molluscs	3 769	465 296	14 946 627	636 520	96 032	**16 148 245**
4. Other aquatic animals	25		381 831	8	5 593	**387 456**
Sub-total	**22 662**	**2 191 356**	**22 945 582**	**2 499 855**	**181 093**	**27 840 547**
TOTAL AQUACULTURE	**Africa**	**Americas**	**Asia**	**Europe**	**Oceania**	**WORLD**
1. Finfish	1 764 864	2 020 726	45 705 773	2 338 320	77 788	**51 907 471**
2. Crustacea	3 733	786 823	6 553 629	310	6 854	**7 351 350**
3. Molluscs	3 769	465 296	15 230 371	636 520	96 032	**16 431 989**
4. Other aquatic animals	25	531	902 936	8	5 593	**909 093**
TOTAL	**1 772 391**	**3 273 375**	**68 392 710**	**2 975 159**	**186 268**	**76 599 902**

Note: Several rows and columns may not add up to the total due to rounding.

aquaculture) contributed 25.5% to the total production, up from 13.8% in 2000 (Figure 3). Within inland water total production of captured and farmed aquatic animals, aquaculture consolidated its dominating share from 68.6% in 2000 to 81% in 2015 (Figure 4).

With almost all farmed aquatic animals destined for human consumption, aquaculture supplied 10.42 kg of food fish for human consumption on world average in 2015, a level further up by 0.28 kg from 10.14 kg in 2014.

Figure 2 – Comparison of World Capture and Aquaculture in the total production of aquaticanimals (excluding algae)

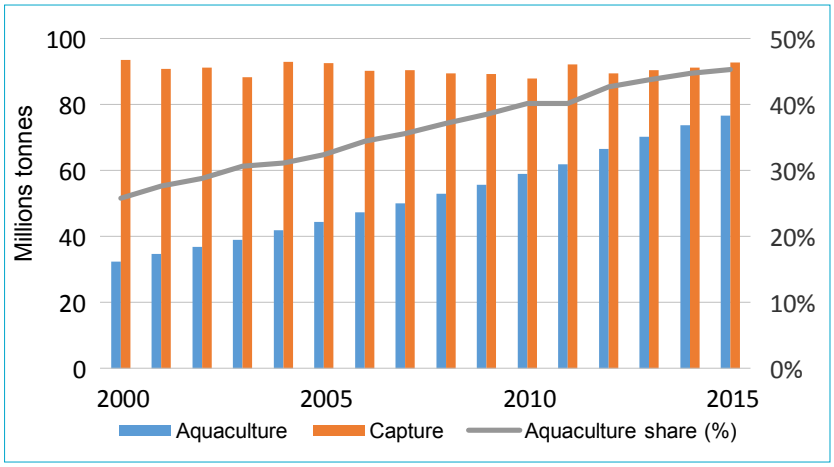


Figure 3 – Comparison of World Capture and Aquaculture in the production of aquatic animals from marine and coastal brackish water (excluding algae)

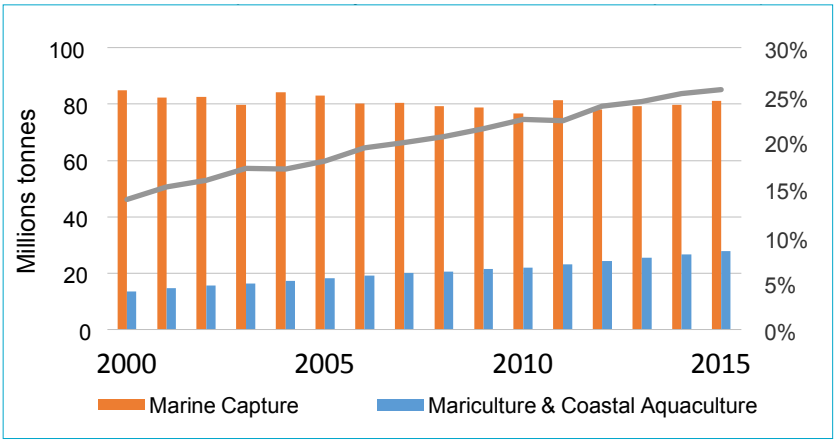
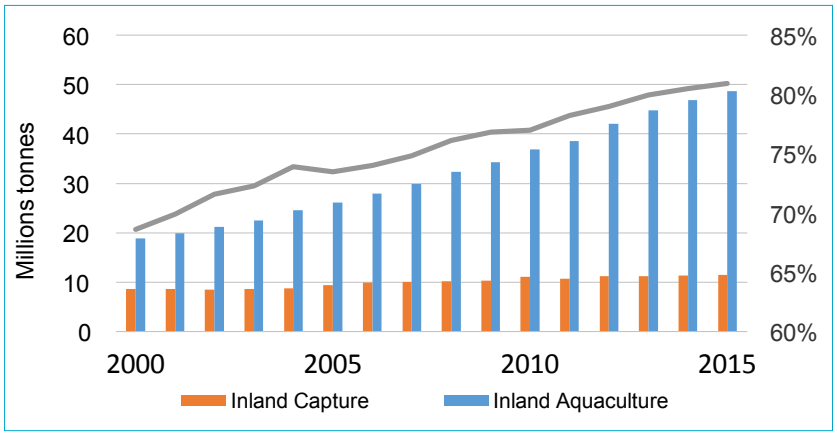


Figure 4 – Comparison of World Capture and Aquaculture in the production of aquatic animals from inland water (excluding algae)



FAO is mandated to collect annual statistics on fisheries and aquaculture worldwide for release to the public as integral part of its regular programme of work. To monitor and report on the sector development status and trend, FAO also publish the State of World Fisheries and Aquaculture biannually, which is largely based on the worldwide collected statistics. However, the situation of national aquaculture statistics collection and reporting to FAO remains unsatisfactory. For 2015 data collection, FAO received data reports from 118 countries and territories only, representing 58% of the aquaculture producer countries and territories in the world. Irrespective of the "developing" and "developed" status, non-reporting countries include a considerable number of global and regional major aquaculture producer countries.

Among the received data reports, the majority of them have substandard reporting quality in terms of completeness, timeliness, consistency and accuracy, etc. In the absence of national reporting (including incomplete reporting), FAO has to harvest national data from known official sources or make estimates based on the best available evidence from various alternative sources. In 2015 about 66 million tonnes (88.7%) of the world food fish aquaculture production quantity corresponds to reported data, while the rest (8.7 million tonnes, 21.3%) corresponds to harvested data and FAO estimates.

Tenth Session of the GFCM Scientific Advisory Committee on Aquaculture

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Group photo of CAQ10 participants

The tenth session of the Scientific Advisory Committee on Aquaculture (CAQ) of the General Fisheries Commission for the Mediterranean (GFCM) of the Food and Agriculture Organization of the United Nations (FAO) was held in Izmir, Turkey, from 27 to 29 March 2017. The meeting was attended by more than 50 delegates, representatives, experts and observers from 13 contracting parties (Albania, Algeria, Croatia, European Union, Greece, Italy, Lebanon, Malta, Montenegro, Morocco, Spain, Tunisia and Turkey), 2 cooperating non-contracting parties (Georgia and Ukraine), 2 intergovernmental organizations (namely the International Union for Conservation of Nature [IUCN] and the International Organisation for the Development of Fisheries in Central and Eastern Europe [Eurofish]), the FAO Fisheries and Aquaculture Department and the GFCM Secretariat.This statutory session, which is organized on a biennial basis, enabled to review the activities and progress achieved by the CAQ over the last two years and to discuss important issues regarding the reorganization of the committee, the work of the GFCM Task Force in charge of elaborating a strategy for the sustainable development of Mediterranean and Black Sea aquaculture, the Information System for the Promotion of Aquaculture in the Mediterranean (SIPAM) and in particular data submission and dissemination aspects, cooperation and technical assistance, as well as the main priorities in the field of aquaculture management and research.

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Members of the new and the old CAQ Bureau, GFCM Chairperson and Secretariat

The CAQ applauded the draft GFCM strategy for the sustainable development of Mediterranean and Black Sea aquaculture elaborated by the Task Force, acknowledging its ambitious goals, and agreed to submit it to the next session of the GFCM (Montenegro, October 2017) in view of its endorsement. Specific recommendations and advice were formulated in relation to aquaculture market and industry, licensing and leasing processes, aquaculture and the environment, aquaculture multi-stakeholder platforms and data submission and dissemination. In addition, the 2017–2018 work plan was agreed upon. Finally, the CAQ elected its new Bureau with Mr Ramón De La Figuera Morales (Spain) as Chairperson, Mr Houssam Hamza (Tunisia) as first Vice-Chairperson and Mr Özerdem Maltaş (Turkey) as second Vice-Chairperson. The next CAQ session will be held in Spain in 2019.

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AQUACULTURE UPDATES BY REGION

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Pilot Implementation of Aquaculture Planning and Management Tools in Selected ASEAN Member States

Following recommendations from the 33rd Session of the APFIC (Asia-Pacific Fishery Commission), the FAO Regional Office for Asia and the Pacific implemented in 2013 a Regional Technical Cooperation Programme (TCP) on "Aquaculture planning and management tools in selected ASEAN (Association of Southeast Asian Nations) Member States" in 2013. The pilot phase includes Indonesia, Thailand and Viet Nam as an important activity to support the implementation of FAO regional initiative on Blue Growth in Asia-Pacific.

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Signing ceremony of TCP/RAS/3511 between DGA-MMAR and FAO Representative Office in Indonesia

The inception workshop for the TCP took place in Bangkok, Thailand from 21–22 July 2016. The main objective of the workshop was to build a solid foundation for the effective implementation of the project through enhanced understanding of all national and regional institutions involved in the project.

Fifteen participants including the National Project Coordinator, key

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government officials supporting the project implementation and representative of partner organization participated in the workshop. During the workshop, the project outcome, outputs, and activities as well as the implementation modality were presented and discussed. Participating countries shared background information for the implementation of the project. Most importantly, each country team worked individually on developing the national workplan for implementing national project activities, which was shared among the national teams.

Following the project implementation plan, three international consultants were recruited to prepare four manuals for tools selected by the participating countries which included (i) aquaculture ecological carrying capacity assessment; (ii) aquaculture feasibility study; (iii) farm level biosecurity plan; and (iv) aquaculture traceability.

Four 3-day regional training workshops were conducted by international consultants during November 2016 to present and discuss the tools in Indonesia, Thailand and Viet Nam. A total of 35 participants, including national consultants and project staff participated in each workshop. The workshop participants commented on the manuals and suggested modifications to the tools. Guided by the international consultants, each country team worked on the development of an implementation plan for piloting each selected tool in their respective country.

Each country team has been working on the preparation of national project activities, which include the national project inception, national training for piloting the selected tools and field piloting of the selected tools. The national inception workshops and national training are scheduled for March 2017 with the support of international consultants. The piloting of the tools will start right after the national training. This project will be completed by the end of 2017.

The implementation of this regional project will help validate the practicality of the selected tools and enable the completion of the tools and corresponding manuals. The experiences and lessons learnt from this pilot phase should serve as a model/example for participating countries, and could also benefit other countries who wish to apply these tools to strengthen their aquaculture planning and management.

This regional project will facilitate the implementation and further development of these and other relevant tools with FAO support. To this end, the results of this project, will be presented in a regional workshop which will be organized for countries that were not directly included in this project.

Building Capacities for Climate Resilient Tilapia Farming in the Philippines

Tilapia is the second important fish species cultured in the Philippines, which is of great importance to the national food security and nutrition. Tilapia farmers have suffered significant production losses due to extreme climate events such as long heat waves. As the result, tilapia pond culture decreased by 35 percent in the past 8 years, imposing considerable threat to the country's food sufficiency and livelihoods. To ensure adequate technical support to food security and livelihoods, a Technical Cooperation Programme (TCP) project was approved to build the capacities of different stakeholder for climate resilient tilapia farming in the Philippines.

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The TCP also aimed to support the implementation of the FAO regional initiative on Blue Growth in the Philippines.

The TCP project started with an inception workshop which was held on 3 March 2015 in Manila. Various project activities were implemented according to the project design throughout the 22 month implementation.

A comprehensive assessment study was conducted on tilapia farmers' climate risk vulnerability

and viable livelihood options for selected areas in the Philippines. Based on this assessment, a package of science-based practical climate-resilient tilapia farming technologies and management practices were developed jointly by the national consultant and the project team.

While focusing on climate resilient tilapia farming practices, local knowledge and farming practices of other aquaculture commodities (shellfish, milkfish, shrimp, grouper, seaweed and mangrove crab) related to climate change/viability adaptation were documented and published as a Bureau of Fisheries and Aquatic Resources (BFAR) Aquaculture Technology Bulletin for sharing with large number of farmers through serious of interactive events organized with support from this TCP.

Farmer-friendly Information, Education and Communication (IEC) products relating tilapia aquaculture and agro-meteorological concepts and pilot testing of applying science-based and practical climate-resilient tilapia farming technologies, were conducted in Minalin, Pampanga and Santiago city.

The project also supported the development and application of enabling tools and information systems for climate resilient tilapia farming and local agro-

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Terminal workshop of TCP/PHI/3502

fishery development planning. The web and mobile application were developed to support the operation of the system. The project also supported the installation of Automated Weather Station (AWS) and maintenance training courses for the AWS.

The project supported a comprehensive social-economics analysis on tilapia farming in selected areas using a questionnaire survey and other interactive data collection tools. The project also reviewed crop insurance services and studied the feasibility to apply a weather index based insurance scheme for tilapia farming.

Based on the market and financial vulnerability of tilapia farmers to climate risks, the following strategies were recommended: (i) better government support; (ii) improved public services including extension and (iii) increased and improved dissemination of climate related information; (iv) mainstreaming aquaculture into local disaster risk reduction management; and (v) strengthening data collection and data management to support aquaculture insurance schemes.

A project terminal workshop was conducted on 18 January 2017 in Manila. The project thoroughly reviewed the project implementation and the main achievement. The project also identified the gaps in delivering the project outcome and outputs.

The project developed a comprehensive approach to build human capacity to increase the resilience of tilapia farming. Such approach can be well adapted for other aquaculture commodities and to a very large extent in the Philippines. The outputs from this project will be shared with other countries in the region. To this end, a regional TCP project has been approved in 2017 to support the scaling up of innovative rice-aquaculture and climate resilient tilapia farming in five focus countries for the regional Blue Growth initiative. Clearly, the outputs of this project and the lessons learnt in its implementation will be important technical inputs for the regional TCP project.

Rice-Fish Culture: An integrated Approach to Efficient Resource Use

In rice production areas, overuse of pesticides and chemical fertilizers decreases terrestrial and aquatic biodiversity while also negatively impacting human health due to direct exposure to toxic pesticides and contaminated water, pest resurgence, degradation of natural resources and decreases in production. Moreover, aquatic biodiversity from rice-based ecosystems, often underappreciated and undervalued, makes a significant contribution to food security in rural rice growing households as well as to the proper nutrition of the family.

Rice-Fish culture is an ancient technique practiced in many areas around the world which is now receiving renewed interest. Rice-fish systems encompass a wide range of aquatic species (including finfish, crustaceans, mollusks, reptiles, insects, amphibians and aquatic plants) used for consumption and/or sale, and integrated farming systems (concurrent, rotational, side-by-side using the same water resources) which are practiced in various intensities of input-use from the harvesting of wild fish to the introduction of cultured fish. These techniques have brought triple-win benefits to farming families by increasing yields, incomes, and levels of nutrition.

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Old man and young children fishing in irrigation canals in the Tasikmalaya District (Java, Indonesia)

FAO has a rich history of supporting Rice-Fish work around the world. Recently, in September of 2016, a workshop and study tour was held in Yogyakarta, Indonesia, in support to the FAO Regional Initiatives on Rice and Blue Growth where participants exchanged knowledge on Farmer Field School curriculum development for promotion of efficient rice farming practices, specifically Rice-Fish farming. Field visits were made to the Sleman district of Java to observe the Rice-Fish farming and a space-row rice planting system known as "jajar legowo" that provides more space for the fish, both of which were piloted by FAO and up scaled by the Indonesian Ministry of Marine Affairs and Fisheries and the Indonesian Ministry of Agriculture.

Separately, Rice-Fish is an integral part of two regional training workshops on selected innovative integrated agri-aquaculture systems and practices being held in 2017: the first by the Songhai Center in Porto Novo, Benin, and the second by the Freshwater Fisheries Research Center in Wuxi, China organized under the Regional Initiative on Sustainable Intensification of Agriculture Production and Value Chains in Africa and the Asia and the Pacific's Blue Growth Initiative, respectively.

In order to increase production in a socially, environmentally and economically sustainable manner, resources need to be used more efficiently, at the same time protecting human health and natural resources without the expansion of agricultural land. FAO's ongoing work with partners on Rice-Fish is one such practice supporting the sustainable intensification of agriculture through integrated approaches to efficient resource use.

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SEE ALSO

FAO Regional Rice Initiative:
www.fao.org/asiapacific/perspectives/regional-rice/en/

FAO Sustainable Intensification of Agriculture Production and Value Chains:
www.fao.org/africa/perspectives/agricultural-landscapes-africa/en

FAO Asia and the Pacific's Blue Growth Initiative:
www.fao.org/asiapacific/perspectives/blue-growth/en

Halwart, M. and M.V. Gupta (eds.). 2004. Culture of fish in rice fields. FAO and The WorldFish Center. 83 p. **www.fao.org/3/a-a0823e.pdf**

Improving Feed Formulation and Better Management Practices for Nile tilapia and Milkfish Culture in the Philippines

Milkfish (*Chanos chanos*) and Nile tilapia (*Oreochromis niloticus*) made up 57.5 and 39.1 percent, respectively, of the Philippines' farmed finfish supply in 2015. Studies have found that substandard feed quality, poor water stability of feed and over feeding contributed to the negative environmental impact of aquaculture in the country. Overfeeding results in excess nutrients entering the water column. Over a number of production cycles, the excess nutrients accumulate on the sea/lake bottom and degrade water quality. Oxygen level in the sediment beneath the cages goes down making the aquaculture area prone to fish kill.

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Typical feeding technique used by pond farmers in the Philippines

Gradual degradation of the culture environment and economic loss from recurring fish kills do stem directly from the linked technical issues of substandard feed quality and poor feed and feeding management. An analysis of the problem suggested however that a more effective approach would be to cast the technical and environmental, and economic problems into the broader sector management - governance - perspective. Thus this three-year project aimed at (i) improving feed formulation and feeding strategy for these two species, (ii) improving feed conversion ratio (FCR), (iii) formulating and promoting cost-effective feed using local ingredients, (iv) improving feeding strategy to reduce FCR, feed wastage and water pollution, and (v) providing guidelines for the feed manufacturers and the farmers. FAO carried out the project in cooperation with the Inland Fisheries and Aquaculture Department (IFAD) of the Bureau of Fisheries and Aquatic Resources (BFAR) of the Government of the Philippines. A number of International and National consultants provided the needed expertise.

The work to improve feed quality began with a detailed literature review of dietary requirements for the two selected species. This informed the preparation of a series of new feed formulations for each species. The protein components of all the dietary formulations were chosen according to their cost, availability in the country (this information was derived from a baseline survey), and their suitability for use in aquafeeds. In all four trial formulations, the essential amino acid (EAA) levels were calculated and where possible balanced according to the known dietary requirements. The four experimental tilapia diets were prepared to contain 33.8 - 34.4 percent protein and 7.2 - 7.9 percent lipid. The gross energy levels of the formulations ranged between 17.3 - 18.0 MJ/kg. Similarly the four experimental milkfish diets were formulated at crude protein levels varying from 31.2 and 34.3 percent, at two crude lipid levels (5.6 and

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Feeding table for milkfish (*Chanos chanos*) to achieve an FCR of 1.5:1

Milkfish daily feeding rate (SFR)

Temp		mean weight (gr.)													
min		20	35	48	60	80	100	150	200	250	300	350	400	450	500
max		35	48	60	80	100	150	200	250	300	350	400	450	500	<
20	22	2.2	1.6	1.2	1.0	1.0	1.0	0.8	0.8	0.8	0.6	0.6	0.6	0.6	0.6
22	24	2.4	1.8	1.4	1.2	1.2	1.2	1.0	1.0	1.0	0.8	0.8	0.8	0.6	0.6
24	25	3.4	2.6	2.0	1.6	1.6	1.6	1.4	1.4	1.2	1.2	1.0	1.0	0.8	0.8
25	26	4.4	3.8	3.2	2.6	2.4	2.4	2.2	2.0	1.8	1.8	1.6	1.4	1.2	1.2
26	27	5.8	4.8	4.0	3.4	3.2	3.0	2.8	2.6	2.4	2.2	2.0	1.8	1.6	1.4
27	28	7.2	5.8	4.8	4.2	4.0	3.6	3.2	3.0	2.8	2.6	2.4	2.2	2.0	1.8
28	29	8.2	7.2	6.2	5.2	5.0	4.6	4.0	3.8	3.6	3.2	3.0	2.8	2.4	2.2
29	30	9.6	8.2	7.0	6.0	5.6	5.2	4.6	4.4	4.0	3.8	3.4	3.0	2.8	2.6
30	31	9.8	8.6	7.4	6.4	6.0	5.4	5.0	4.6	4.4	4.0	3.6	3.2	3.0	2.8
32	33	8.4	7.2	6.2	5.4	5.0	4.6	4.2	3.8	3.6	3.4	3.0	2.8	2.6	2.2
33	34	6.8	5.6	4.8	4.2	4.0	3.6	3.2	3.0	2.8	2.6	2.4	2.2	2.0	1.8

Feeding table for Nile tilapia (*Oreochromis niloticus*) to achieve an FCR of 1.2:1

Nile Tilapia daily feeding rate (SFR)

Temp		mean weight (gr.)													
min		20	35	48	60	80	100	150	200	250	300	350	400	450	500
max		35	48	60	80	100	150	200	250	300	350	400	450	500	<
20	22	1.5	1.1	0.8	0.7	0.7	0.7	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4
22	24	1.6	1.2	1.0	0.8	0.8	0.8	0.7	0.7	0.7	0.5	0.5	0.5	0.4	0.4
24	25	2.3	1.8	1.4	1.1	1.1	1.1	1.0	1.0	0.8	0.8	0.7	0.7	0.5	0.5
25	26	3.0	2.6	2.2	1.8	1.6	1.6	1.5	1.4	1.2	1.2	1.1	1.0	0.8	0.8
26	27	4.0	3.3	2.7	2.3	2.2	2.1	1.9	1.8	1.6	1.5	1.4	1.2	1.1	1.0
27	28	4.9	4.0	3.3	2.9	2.7	2.5	2.2	2.1	1.9	1.8	1.6	1.5	1.4	1.2
28	29	5.6	4.9	4.2	3.6	3.4	3.2	2.7	2.6	2.5	2.2	2.1	1.9	1.6	1.5
29	30	6.6	5.6	4.8	4.1	3.8	3.6	3.2	3.0	2.7	2.6	2.3	2.1	1.9	1.8
30	31	6.7	5.9	5.1	4.4	4.1	3.7	3.4	3.2	3.0	2.7	2.5	2.2	2.1	1.9
32	33	5.8	4.9	4.2	3.7	3.4	3.2	2.9	2.6	2.5	2.3	2.1	1.9	1.8	1.5
33	34	4.7	3.8	3.3	2.9	2.7	2.5	2.2	2.1	1.9	1.8	1.6	1.5	1.4	1.2

11.2 percent), and at gross energy levels that ranged between 17.4 - 19.0 MJ/kg.

The second objective to improve feeding strategy was informed by a baseline survey of farmers' feeding practice in pond and cage culture. From the survey indications, three feeding strategies were developed and tested in small experimental ponds and then on-farm in cages and ponds. These three strategies included the development of detailed feeding tables based on specific growth rate potential and the desired feed conversion rate (FCR), which were 1.2 for Nile tilapia and 1.5 for milkfish. To determine a feeding rate (percent body weight/day), the US Soybean Export Council (USSEC) "90 percent satiation feeding technique" and standard commercial feeding tables were used as guidances.

The four feed formulations and three feeding strategies were tested for each species at small-scale trials. The best performing tilapia feed had a calculated crude protein level of 34.4 percent and crude lipid level of 7.4 percent. The best performing milkfish diet had a calculated crude protein level of 34.3 percent and crude lipid level of 11.2 percent.

The best performing formulation and feeding strategy were chosen and tested at farmer scale trials in Taal Lake for tilapia and Bulacan for milkfish. The results are compared with the normal feed and feeding strategy used by the farmer.

From the results of the trials as well as surveys on how farmers manage their farms and deal with risks, the project developed better feeding management practice guidelines, a strategy on how farmers can cope with production and marketing risks, and recommendations on governing the feed manufacturing sub-sector. These were validated and finalised during a stakeholders workshop held in Manila in December 2016.

Improving feed formulation and feeding strategy for key aquaculture species reduces production costs for the farmer, reduces nutrient waste output to the environment leading to a more economical and environmentally sustainable industry. The results and lessons learnt from this project can be applied to other countries in the region and similar studies financed for other key aquaculture species. Along with this Technical Cooperation Project (TCP), three other TCPs being implemented in South (Bangladesh and Sri Lanka) and Central Asia (Kyrgyzstan) are particularly designed to improve feed quality and use. Each project had addressed a number of fundamental and practical feed production and use issues. Collectively the results of these projects will provide a regional recommendation.

SEE ALSO

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Ramakrishna, R., Shipton, T.A. & Hasan, M.R. 2013. Feeding and feed management of Indian major carps in Andhra Pradesh, India. FAO Fisheries and Aquaculture Technical Paper No. 578. Rome, FAO. 90 pp. **www.fao.org/docrep/019/i3146e/i3146e.pdf**

Hasan, M.R. & New, M.B., eds. 2013. On-farm feeding and feed management in aquaculture. FAO Fisheries and Aquaculture Technical Paper No. 583. Rome, FAO. 67 pp. Includes a CD–ROM containing the full document (585 pp.). **www.fao.org/docrep/019/i3481e/i3481e.pdf**

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Unlocking the Potential of our Marine and Renewable Energy Resources through the Power of Research and Innovation

Over 70 percent of the world's surface is taken up by ocean space. Thus, significant areas of the world's ocean space remains unused and can potentially provide immense opportunity for economic growth and resource use. Moreover, with an ever growing population and uses of land areas reaching their limit it is timely to focus on the worlds' oceans to solve some of the world's major issues such as security of food supply and energy.

Our oceans are important drivers of economic growth. They provide natural resources, access to trade and transport and opportunities for leisure activities. As maritime activity increases, however, so does the competition for space as coastal areas become overcrowded. This led the European Commission to publish a call in 2014 asking researchers to prepare for the 'future innovative offshore economy'. Expecting economic activities to move further offshore as competition for space increased, this call was designed to promote smarter and more sustainable use of our seas. It was in response to this call that the Marine Investment in the Blue Economy (MARIBE) project was initiated with the aim of promoting growth and jobs within the Blue Economy.

The MARIBE project started in March 2015, with a duration of 18 months and a total budget of 2 million euros (USD 2 200 000) under the European Commission's Horizon 2020 programme. It was led by the Centre for Marine and Renewable Energy (MaREI) at the University College Cork in Ireland. A total of 11 partners from Ireland, United Kingdom, Belgium, Spain, Italy, Malta and the Netherlands, including FAO, contributed to the project.

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Development solution

The primary objective of MARIBE was to investigate the potential of combining maritime sectors in the same place or on a specifically built platform in order to make more efficient use of space and resources. It paid particular attention to new and emerging industries that could benefit greatly from the synergies created, increasing their chances of survival and enabling future growth. The MARIBE project covered the five 'Blue Growth (BG)' sectors; aquaculture, energy (wave and tide), energy (offshore wind), biotechnology and seabed mining. MARIBE also included the four 'Blue Economy' sectors; fisheries, offshore hydrocarbons, shipping and tourism.

In order to achieve its aim, MARIBE conducted:

- A study on "*Socio-economic trends and EU policy in the offshore economy*", to review each sector from a business lifecycle and socio-economic perspective. A review of the policy and planning frameworks that applied to the sectors was conducted for each of the sea basins under study Baltic basin, Atlantic basin, Mediterranean and Black sea Basin, and the Caribbean Basin;
- A study on "*Technical and non-technical barriers facing Blue Growth sectors*", to look at barriers by sector and also by combination and to identify the barriers that existed when two sectors shared marine space or multi-use platforms;
- An "*Investment community consultation*" to assess the current investment environment, as well as best practices and key barriers for investment;
- A "*Business model mapping and assessment*" to analyze and map the business models that lie behind Blue Growth/ Economy industries.

Building on the above studies, MARIBE then assessed the potential for each of sector falling within its scope to combine their activities with those of other Blue Growth or Blue Economy sectors. The potential for combination was rated from a technical, environmental, socio-economic, financial and commercial perspective. This resulted in the identification of 24 potential Blue growth combinations. Blue Growth Companies were then matched to the chosen Blue Growth combinations which were then shortlisted in liaison with the European Commission. This short list formed the basis for the selection of nine case studies of combination concepts. Table 1 lists the nine case studies, the companies that participated, their relevant Blue growth sectors and appropriate basis (Table 1).

To maximize the opportunity for each case study to develop a robust business case, projects were reviewed by an independent panel of experts. The companies involved presented their business case to the panel of experts which included representatives from Ernst & Young, Black & Veatch, DNB Norway (i.e. Norway's largest financial services group), Scottish Investment Bank, Offshore Renewable Energy (ORE) Catapult, International Energy Agency as well as relevant trade associations including the European Aquaculture Society, Federation of European Aquaculture Producers and the World Ocean Council. The event, which was held in Brussels on the 15-16 of June 2016, gave the companies an opportunity to communicate their projects to industry experts and receive impartial advice. Their feedback was recorded and incorporated when revising the final reports of each project.

Key results

The main results included: two studies on socio-economic trends and EU policy in the offshore economy and technical and non-technical barriers facing Blue Growth sectors, respectively, in four sea basins; an investment community consultation; a business model mapping and assessment; 24 potential combinations for BG/BE sectors; nine sector combinations (or case studies); and a two-day advisory session.

Table 1 – Selected maritime sector combinations

Case study	Basin	Sector 1	Sector 2	Companies
1	Atlantic	Floating Offshore Wind	Wave	www.floatingpowerplant.com
2	Canaries - Atlantic	Aquaculture	Floating Offshore Wind	Besmar, Cobra, ACS
3	Caribbean - French Guiana	Floating terminal/ Shipping	Aquaculture	www.portdeguyane.fr
4	Atlantic	Floating terminal/ Shipping	Wave	http://floatinc.com
5	Atlantic	Wave	Aquaculture	www.wavedragon.net www.seaweedenergysolutions.com/en
6	Mediterranean	Wave	Aquaculture	http://albatern.co.uk www.aquabt.com
7	Atlantic	Wave	Floating Offshore Wind	www.jjc.ie
8	North Sea	Aquaculture	Fixed Offshore Wind	
9	Mediterranean	Floating Offshore Wind	Desalination	www.ecowindwater.gr

Potential for upscaling

In the MARIBE final report delivered directly to the European Commission in late 2016, MARIBE recommended that further funding should be given to the combination of maritime sectors. Based on MARIBE's review of the funds invested to date by the commission and MARIBE case study projects investigated, a series of calls for proposals were recommended with a budget of approximately 35 million euros (USD 40 000 000) in the next round of Horizon 2020 funding calls to promote multi-use of space projects.

Conclusions

Economic activities in Europe's seas and coasts are expected to intensify, diversify and expand further offshore. The development of large scale activities offshore and in deep sea areas requires overcoming a series of technological and non-technological challenges and assessment of the most promising and sustainable business models. One way to make use of our seas in a more sustainable and less disruptive manner is to combine different activities at sea, either multiple-use of space or in multi-purpose platforms.

The MARIBE project met the expectations of the European Commission by generating valuable information on how various combinations of marine activities are (or could become) financially viable. A follow-up activity to this effort by MARIBE and/or FAO could be to generate more detailed financial information about the operational aspects of offshore mariculture for different farming systems in order to fully understand potential synergy between aquaculture and other maritime activities.

SEE ALSO

Aguilar-Manjarrez, J. 2016. Horizon 2020: Promoting sustainable aquaculture. *FAO Aquaculture Newsletter*, No. 55, pp 26–27.

FAO. 2015. Achieving Blue Growth through implementation of the Code of Conduct for Responsible Fisheries. Policy Brief. Rome, FAO. (also available at **www.fao.org/fileadmin/user_upload/newsroom/docs/BlueGrowth_LR.pdf**).

To learn more about the MARIBE project, and its key results, please visit the project website at: **www.maribe.eu**

Definitions used in the MARIBE project:

Blue Growth is the long-term strategy to support sustainable growth in the marine and maritime sectors. "Blue" refers to all marine related affairs, "Growth" refers to new innovative technologies that have high potential for creating new jobs and economic growth for the future.

Blue economy refers to all existing marine enterprises and implies that they are at a matured or developed phase of the life cycle.

Synergies: Blue economy provides experience, lessons learnt, and possibly financial investment to the newer Blue Growth sectors, while Blue Growth reinvigorates declining Blue Economy with new business models, allowing Blue economy either to re-invent itself , or to diversify its portfolio.

Grand Port Maritime de Guyane is developing a floating multi-use terminal. The platform will serve three main sectors – shipping (container transfer hub), oil & gas logistics hub, and aquaculture support.
www.portdeguyane.fr

Floating Power Plant is a Danish company that develops the world's only offshore proven combined wind and wave system with the goal of producing competitive power at water depths over 45 meters.
www.floatingpowerplant.com/

Ecowindwater has designed a multiuse platform to address the scarcity of freshwater and energy commodities in identified domestic and global markets.
www.ecowindwater.gr/ViewShopStaticPage.aspx?ValueId=1997

Float Incorporated is a corporation providing services that include research, design and development of marine oriented products and specializes in very large floating platforms.
http://floatinc.com/AboutUs.aspx

Wavedragon. Pioneering large scale ocean energy solution for bulk electricity generation.
www.wavedragon.net

J.J. Campbell and Associates in partnership with Wave Energy Ireland to develop clean, renewable and sustainable technologies to convert the abundant wind and wave energy resource available off the west coast of Ireland, and at other locations around the world, to usable electrical power
www.jjc.ie/j-j-campbell-in-renewable-energy-sector

The **MERMAID project**, consisting of a consortium of 28 partners, will develop concepts for a next generation offshore platforms for multi- use of ocean space for energy extraction, aquaculture and platform related transport
www.vliz.be/projects/mermaidproject/index.html

Albatern. Clean, green electricity from the waves. WaveNET is a radical new wave energy device that captures energy from ocean waves and converts it into sustainable low-carbon electricity.
http://albatern.co.uk

Enhancing the Quality of Fisheries and Aquaculture Emergency Preparedness and Response in the Near East and North Africa Region

The FAO Regional Office for the Near East and North Africa (FAO-RNE) organized a Regional Training on Fisheries and Aquaculture Emergency Response, in collaboration with the WorldFish in the premises of the Africa Aquaculture Research and Training Center in Abbassa, Egypt, 5-7 December 2016.

Twenty participants attended the training from Egypt, Iraq, Jordan, Lebanon, Libya, Mauritania, Palestine, Syria, Sudan and Yemen. They covered a wide range of expertise and institutions, from fisheries and aquaculture ministerial and marine research centres staff to civil society and non-governmental organizations representatives and FAO emergency national staff. With the aim to establish a regional network of experts from both fisheries and aquaculture as well as emergency backgrounds, appropriately informed and trained in this area of work.

Responding to emergencies and disasters, whether natural or human induced, has become an important part of the work of

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Group photo during the Regional Training

FAO-RNE. Regretfully the situation is likely to continue into the near future, as the impacts of climate change and protracted crises such as conflict are not likely to soften soon. The overall aim of the three days' training was to develop regional and national capacity to respond to emergencies affecting the fisheries and aquaculture sectors and to build back better. More specifically, the learning objectives of the training were to understand the relationship between fisheries, aquaculture, emergency, food security and livelihoods; and to assess post-disaster needs and to identify appropriate best practice responses and standards, both, in emergency interventions in fisheries and aquaculture.

The training programme was built upon the FAO Guidelines "Fisheries and Aquaculture sector on Damage and Needs Assessments in Emergencies" and "Fisheries and Aquaculture Emergency Response Guidance" (More details on the guidelines in the "SEE ALSO" box).

The training was based on practical case studies and exercises conducted both in groups and plenary. Presentations on fisheries and aquaculture characteristics and how these can be affected by an emergency, offered an overview of the essential contribution of the two sectors to the livelihoods and food security in the region. The context of the humanitarian work was presented and trainees learned about the

different types of assessments needed and the importance of considering always all the steps of the value chain in post-emergency studies.

An important part of the training was focused on common best practices in emergency, fisheries and aquaculture. Per request of the participants, a larger session was organized on the aquaculture best management practices (BMP), as the sector is gaining importance in the region and the emergency response actions on aquaculture are completely unknown. Special attention was given to the opportunity of "Building Back Better" that an emergency status could offer to the aquaculture sector. During the training, the following points were presented and widely discussed: (i) chance to improve the zoning and density of farms; (ii) building the farms more environmental friendly; (iii) use of technologies that are more suitable; (iv) developing financial services for farmers; (v) include bio-security and risk assessment measures; and (vi) ensuring the rehabilitation is in-line with the government policies.

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Trainees formulating fisheries and aquaculture emergency response programs

There is a crucial need to strengthen the work on fisheries and aquaculture emergency response to reinforce the resilience of the fishing and aquaculture communities all along the Near East and North Africa Region. For this reason, FAO is working on the translation of the guidelines into Arabic; and FAO-RNE has started, following a participant's request, to mobilize funds to organize national trainings, most likely during 2017, to begin with Mauritania, Yemen and the sub-regional office of North Africa.

SEE ALSO

Brown, D. & Poulain, F. (eds). 2013 *Guidelines for the fisheries and aquaculture sector on damage and needs assessments in emergencies.* Rome, FAO. 114 pp.
www.fao.org/3/a-i3433e.pdf

Cattermoul, B.; Brown, D. & Poulain, F. (eds). 2014. *Fisheries and aquaculture emergency response guidance.* Rome, FAO. 167 pp.
www.fao.org/3/a-i3432e.pdf

FAO Regional Office for Near East and North Africa
www.fao.org/neareast

WorldFish Center
www.worldfishcenter.org

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Technical Workshop on Marine Cage Culture in the Islamic Republic of Iran

Due to favourable environmental and socio-economic conditions, The Islamic Republic of Iran has good potential for marine cage culture, particularly off its southern coast. At present, the government is strongly supporting the expansion of the sector through the Iranian Research Institute (IFO) and adequate policies and incentives to encourage the private sector to invest. However, lack of technical capacity is one of the major constraints that the country is facing for cage culture to further expand. To this end, a technical workshop on "Marine cage culture in the Islamic Republic of Iran" was organized by the Iran Fisheries Organization (SHILAT) of the Ministry of Jihad-e Agriculture with support of FAO's Fisheries and Aquaculture Department. The objective of the workshop was to provide a technical overview on marine cage culture in the Islamic Republic of Iran to enable IFO be in a better position to develop a programme outline.

The workshop took place from 26–29 September 2016, at the Iranian Fisheries Organization in Tehran. It was opened by Mr Hossein Abdolhay, Head of Aquaculture Department, Iranian Fisheries Organization to more than 100 participants from all over the country (including researchers, national and regional governmental officers, equipment suppliers and investors). In his opening remarks, Mr Serge Nakouzi, FAO Representative to the Islamic Republic of Iran underscored the increasingly significant role played by aaquaculture and notably by mariculture in ensuring global and national food security amidst a growing demand. He suggested that developing marine cage culture in the Islamic Republic of Iran would benefit the country in responding to its growing demand for aquaculture products. The country has some 50 years' experience in aquaculture, mainly in pond culture of freshwater fish including major Chinese carps and the rainbow trout.

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Floating cages for rainbow trout, production capacity of 300 tonnes, located in Karoon 4 Dam in Lordegan, Islamic Republic of Iran

The workshop was in the form of plenary presentations followed by facilitated discussions. FAO aquaculture officers presented a global perspective on "cage aquaculture development" and "marine spatial planning". In addition, there were nine technical presentations from different experts covering: site selection for cage culture in the Persian Gulf, Oman Sea and Caspian sea; suitable species for cage culture in the Islamic Republic of Iran; traditional cage nets and setting up a commercial farm; research needs for cage culture development; mooring design in offshore cage farming; and recirculation aquaculture systems for fry production.

The Iranian Research Institute expressed strong interest for technical assistance by FAO. FAO could have an important role to play in order to: (i) provide guidance on sustainable aquaculture development; (ii) stimulate multi-stakeholder dialog to work towards ensuring long-term sustainable aquaculture; and (iii) promote the use of appropriate activities and tools/models (e.g. carrying capacity) to improve ownership and understanding of the planning processes for marine cage culture development and of the contribution of fish to food security and nutrition. Follow-up actions include the preparation of a "road map" for Iranian marine cage culture that would prioritize immediate to long-term activities, and propose responsibilities, leadership and participation of various institutions.

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SEE ALSO

BLOGS

FAO Stresses Criticality of Marine Cage Culture for Iran
www.fao.org/iran/news/detail-events/en/c/436254

Developing sustainable mariculture in Iran
www.fao.org/blogs/blue-growth-blog/developing-sustainable-mariculture-in-iran/en

Third Regional Consultation on the Establishment of the Red Sea and Gulf of Aden Aquaculture and Fisheries Organization (RAAFO)

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Group photo of participants

The FAO Regional Office for the Near East and North Africa and the FAO Fisheries and Aquaculture Department, in collaboration with the Coordination Group (Egypt, Saudi Arabia and Sudan), convened the Regional Consultation for the Establishment of the Red Sea and Gulf of Aden Aquaculture and Fisheries Organization (RAAFO), in Cairo, Arab Republic of Egypt, from 28 November to 01 December 2016. It was attended by participants from Egypt, Eritrea, Jordan, Sudan, Saudi Arabia, and Yemen, in addition to the FAO secretariat. Djibouti and Somalia sent their apologies.

The concerned Arab and African countries requested the technical assistance to FAO at the 28th Session of the Committee on Fisheries (COFI), held in Rome from 2-6 March 2009, for the establishment of a regional fisheries management organization in the Red Sea and Gulf of Aden. Significant progress had been made since 2011, including the convening of four meetings and consultations, and resulting in four key draft documents, including the Convention itself, which has undergone a number of revisions at these meetings. Key items on the consultation agenda included reviewing the draft Convention Agreement, and discussing the financial aspects and sustainability of RAAFO.

This third official consultation yielded a number of key outcomes, with clear ways forward and actions for both FAO and potential RAAFO member countries. The consultation exercise and its outcomes mark an important shift of responsibility and ownership to the potential member countries. It was decided that consultation participants would communicate the progress made and facilitate high-level support to ensure continued work on RAAFO. Additionally, further review and feedback on the draft English and Arabic texts would be provided from each country. The Coordination Group would take on the role to receive the feedback and comments and reconcile the Arabic and English texts; once the texts are finalized and circulated to the eight Arab and African coastal countries of the Red Sea and Gulf of Aden, a meeting of the plenipotentiaries may be convened. Regarding the financial aspects of RAAFO, different options were considered, but it was considered too early to make any decisions on financial commitments.

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The Importance of Aquaculture in North Africa is Increasing

SUMMARY

Aquaculture is a quite recent activity in the North Africa region. Indeed, in the Maghreb area from Mauritania to Libya, aquaculture, whether marine or freshwater, has not yet crossed the threshold where it can be considered as a competitive sector compared to capture fisheries.

This article provides some insights on aquaculture development in five countries in North Africa: Libya, Tunisia, Algeria, Morocco and Mauritania. The current contribution of aquaculture to fish consumption and to the GDP in the region is insignificant (except in Tunisia). In addition, the aquaculture sector is generally fragile and highly sensitive to external pressure, including environmental, economic, social and financial conditions. There are also several gaps in governance and management of the sector. In many countries, governance and regulation of the sector are carried out by more than one authority, leading to poor management strategies and policies and overlaps in fisheries and aquaculture legislation. However, governments are making important efforts to develop the sector to respond internal market demand for fish and for creation of employments.

L'aquaculture en Afrique du Nord gagne du terrain

L'aquaculture de façon générale est une activité récente en Afrique du Nord. En effet, dans l'espace Maghrébin situé entre la Mauritanie et la Lybie, l'aquaculture qu'elle soit marine ou d'eau douce n'a pas encore franchi le seuil où elle peut être considérée comme une activité compétitive de la pêche de capture.

Bien que les acquis soient sensiblement différents d'un pays à l'autre, en raison notamment de conditions physiques multiples ou d'abondance de ressources marines qui font que certains pays ont négligé volontairement son développement. Les productions aquacoles dans la sous-région enregistrent une progression régulière et de nombreuses études et expérimentations ont été conduites pour promouvoir cette activité avec une motivation de plus en plus justifiée par la baisse continue des rendements de la pêche de capture et la croissance de la production aquacole comme solution future.

Au niveau de la sous-région les expérimentations et pratiques capitalisées traduisent la volonté des pays d'aller en avant vers un développement du secteur aquacole ce qui correspond bien aux programme de développement durable à

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Harvesting gilthead seabream from a floating cage, Monastir, Tunisia
Récolte de dorade royale d'une cage flottante, Monastir, Tunisie

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l'horizon 2030 de la pêche et de l'aquaculture présenté lors de la 32ième Session du Comité des pêches (COFI) de la FAO, tenu le 11-15 Juillet 2016 à Rome, Italie (COFI/2016/Info.20 - www.fao.org/3/a-mq652f.pdf).

Prise individuellement, la Tunisie a développé une expérience importante tant au plan technique et scientifique qu'au plan de la production. Les espèces qui ont été expérimentée en Tunisie et qui ont réussi sont notamment, la dorade royale (*Sparus aurata*), le bar européen (*Dicentrarchus labrax*), le tilapia ainsi que les palourdes en plus d'expérimentation sur l'élevage de poisson en eau douce. La dorade royale, le bar européen et les palourdes représentent les principales espèces produites pour la consommation nationale et l'exportation vers le marché européen.

Le Maroc qui élève des espèces piscicoles dulcicoles s'oriente désormais vers la production des poissons d'eau de mer avec un objectif ambitieux de 200 000 tonnes par ans d'où la mise en place récente d'une agence dédiée à l'aquaculture, l'Agence Nationale pour la l'Aquaculture (ANDA). L'ANDA actuellement en partenariat avec la FAO est en train de développer et valider la stratégie nationale du secteur aquacole.

En Algérie, les réalisations sont moins significatives, limitées à des opérations de repeuplements des plans d'eau continentaux avec des alevins de poissons dulcicoles, importées le plus souvent, ainsi que de coquillages placées en grossissement. Néanmoins les efforts récents de l'Algérie en matière de promotion de l'aquaculture en milieu désertique et marin ont permis de faire un état des lieux du secteur au niveau national et aussi des conditions physiques et environnementales. A travers des subventions financières et le support technique du gouvernement, l'objectif final est celui d'accélérer le développement du secteur tant en milieu continental que marin.

Depuis 2007, la FAO a fourni assistance technique au gouvernement, à travers plusieurs programmes de coopération technique (PCT) notamment, TCP/ALG/3103 : Support à l'aquaculture saharienne et la valorisation des étangs salés (2007-2008); TCP/ALG/3402 : Programme d'assistance technique pour le développement de l'aquaculture en milieu désertique en Algérie (2013-2014) ; TCP/ALG/3501 Appui technique à l'exécution du Programme de développement de l'aquaculture 2015-2020 et perspectives, filière aquaculture marine. Ces programmes ont permis aux fonctionnaires du Ministère de l'Agriculture, du Développement rural et de la Pêche de mieux suivre la validation et le lancement de projets aquacoles de la part des investisseurs privés. Actuellement 25 projets aquacoles (production de dorade, de bar en cages, de moules et d'huitres sur filières) sont opératifs le long de la cote algérienne.

En Mauritanie et en Lybie l'aquaculture demeure encore au stade embryonnaire. Cependant, la Mauritanie a élaboré avec l'appui de la FAO une ébauche de plan de développement de l'aquaculture et de la pêche continentale. Des initiatives privées ont été conduites il y a quelques années déjà tant pour le grossissement des huitres creuses[1] dans la Baie de l'Etoile. Aussi une expérimentation d'une durée de 4 ans dans la Baie de l'Etoile, avec un appui de la coopération allemande (GIZ), a permis de tester la faisabilité technique de l'élevage des bivalves à l'intérieur de la Baie du Lévrier. Cet élevage se compose d'huîtres creuse du Pacifique (*Crassostrea gigas*) importées sous forme de naissains, de palourdes croisées d'Europe (*Ruditapes decussatus*), de moules (*Perna perna*) et de coques communes (*Cerastoderma edule*). Au stade actuel, la production annuelle mauritanienne, estimée à moins de 10 tonnes, reste très modeste. A cette production expérimentale à caractère commercial, s'ajoute une autre à caractère social axée sur la pisciculture dans le plan d'eau de Bakhaw (Boghé) encouragée par la FAO et l'UNICEF. Actuellement la FAO, dans le cadre d'un PCT, conduit des études sur les perspectives de développement de la pisciculture et de la pêche continentale dans les plans et affluents d'eau douce du pays.

En Lybie, le programme UTF/LIB/047/LIB « Libya Umbrella programme to support fisheries » a prévu une composante spécifique au développement de l'aquaculture en milieu marin. Le projet vise à doter le centre de

1 A marée haute, impossible de localiser l'emplacement des parcs à huîtres. C'est à marée basse, lorsque l'eau de la Baie se retire vers l'Océan, que les dizaines de poches en plastique tressé font leur apparition. Comme un mirage. Semés en février 2008, les premiers 'naissains' ont donné dix mois plus tard des huîtres pleines et généreuses. « *J'ai été extrêmement surpris de la vitesse avec laquelle nous avons pu obtenir des huîtres commercialisables,* explique Eric Pannequin, consultant français depuis deux ans sur le projet, *qui ajoute : A titre de comparaison, en Europe il faut en moyenne 24 à 36 mois pour produire une huître* ». La Mauritanie, connue jusqu'ici pour ses eaux très poissonneuses, pourrait aussi se révéler un petit paradis conchylicole (Extrait de l'article. La Mauritanie : futur eldorado pour les huîtres ? Par Manon Rivière article publié le 22/01/2009 dernière et diffusé sur Radio France Internationale).

recherche de Tajoura d'une écloserie et d'une unité d'élevage de poissons avec l'objectif de promouvoir cette activité au moyen et long terme afin d'attendre une production commerciale. Une partie du montant de l'ordre de plus de 8 millions de dollars sera consacrée au renforcement des capacités des fonctionnaires et experts nationaux.

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Nile tilapia harvesting in a concrete pond in the desert, Ouargla, Algeria
Récolte de tilapia du Nil dans un bassin en ciment en milieu désertique, Ouargla, Algérie

Dans au moins quatre pays, l'Algérie, le Maroc, la Mauritanie et la Tunisie, il y a une véritable ambition de développer l'aquaculture marine et d'eau douce qui se traduit dans les instruments politiques à savoir les stratégies nationales de développement du secteur et les plans de gestion qui ont accordé une place de plus en plus importante au secteur aquacole. Dans certains cas ils ont mis en place des organes institutionnels dédiés spécifiquement au secteur en plus de l'effort conduit par leur institutions de recherches en matière de prospection et d'analyse des conditions favorables à la promotion de l'aquaculture. En matière d'aménagement des zones allouées à l'aquaculture (AZA), la Tunisie et l'Algérie ont fait des progrès importants dans l'identification des AZAs le long de leurs façades maritimes.

Mais d'une façon générale on peut affirmer que l'aquaculture dans cette sous-région, est encore freinée par de nombreux obstacles d'ordre, juridique, technico-économiques en plus d'autres contraintes liées au manque de moyens financiers et de connaissances techniques et scientifiques.

D'autres préoccupations liées au suivi des facteurs environnementaux et des aspects pathologiques sont souvent évoquées par les responsables. Ils nécessitent une prise en charge en vue d'assurer une bonne gouvernance. Par le passé, le secteur aquacole a souffert d'une mauvaise compréhension liée à des questions de qualité environnementale des sites exploités.

De nombreuses difficultés nécessitent d'être écartées. Il s'agit :

– Des questions de gestion des espaces adaptés à l'aquaculture. Cela pose des problèmes de cohabitation et des confits possibles avec les autres activités économiques et industrielles.
– L'accès aux intrants en particulier les alevins, l'aliment et l'équipent représentent des éléments essentiels pour un développement durable du secteur.
– La formation et l'encadrement des investisseurs privés et des techniciens aquacoles.
– La pathologie : conditions d'élevage, les maladies notamment prévention et contrôle.
– Les coûts de production, les marchés et les investissements.

Malgré ces contraintes, on peut conclure que le débat sur l'intérêt de l'aquaculture et de sa contribution future à l'alimentation sont dépassés tant au plan international qu'au niveau de la sous-région: Il serait souhaitable de passer au stade de l'analyse et du diagnostic vers une production industrielle durable en aquaculture.

Inclusion of Fish in School Feeding Programs: Recent Efforts in Latin America

The benefits of fish to human health have been extensively researched, reviewed and published worldwide over the last 15 years. As a result, increased social awareness has led to the highest historic world average per capita consumption of fish (20 kg per annum according to FAO, 2016). Nonetheless, fish consumption among and within global regions is very asymmetric. In Latin America, whilst the average annual per capita consumption is 9 kg, a wide variance among populations is observed (0-36 kg/caput/annum). This is also true among age groups of countries of the region, with less fish consumed by children. Moreover in many territories, under- and/or malnutrition are combined with a lack of good sources of quality proteins, fats and micronutrients, which fish readily provides.

The overall stunting prevalence in children under 5 years old in LAC countries amounted to 11.3% (6.1 million children) in 2015 and almost 4 million of obese children (FAO-OPS-OMS, 2017). This proportion is much larger in many rural indigenous populations of mid-altitudes and highlands; for example in Guatemala, where such an indicator can reach as much as 55% in some communities (ENSMI, 2016).

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Alejandro Flores (FAO-Officer) facilitates the discussion during the sub-regional forum

Within this context, FAO´s regional strategies and actions in the region to combating both hunger and malnutrition include strengthening school feeding programs (SFP) in rural areas. Legal frameworks and policies, linkages between SFP and small-scale farmers, basic infrastructure, as well as local community and institutional capacities, are thus built or improved through such programs. However, fisheries and aquaculture products have not been traditionally included.

In 2016, a regional strategy was designed to include fish in SFP. The approach has been to liaise with key sectorial national authorities (i.e. fisheries, education and health authorities) or parliamentarians involved in SFP or fisheries. A series of national fora have been organized jointly with such institutions in Mexico, Guatemala, Colombia and Paraguay; as well as another at a Sub-regional level with participation of all Central American countries, namely Belize, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panama.

The objective of such fora are threefold: i) Sensitize the non-fisheries authorities on the benefits of fish consumption on infants´ health. This is done through scientific information and success stories of fish inclusion in SFP; ii) Promote inter-institutional articulation of fisheries, health and education authorities, to synergize in the implementation of national actions to promote the inclusion of fish in SFP´s, and iii) to formulate collectively a road map for the design and implementation of a pilot-scale project to include fish in SFP´s in territories with high prevalence of stunting and/or child obesity.

Even though the program is still in its early stages, results so far are encouraging. In Mexico, the Senate is already discussing modifying the SFP legal framework, to include fish (seafood). In Paraguay the inclusion of fish has already been approved, and pilot-scale projects have started in marginalized

territories of Costa Rica, Guatemala and Honduras.

Beyond the nutritional benefits expected from this program, the linkage of small-scale fisher folk and aquaculture farmers to the SFP as suppliers, will also contribute to the local economy of rural fishing and aquaculture communities.

SEE ALSO

ENSMI. 2016. Encuesta Nacional del Sector Salud de Guatemala, 2014-2015. Ministerio de Salud Pública y Asistencia Social/Instituto de Salud Pública/ Instituto Nacional de Estadísticas. Guatemala, 87p.

FAO. 2016. T*he State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all.* Rome. 200 pp.

FAO-OPS-OMS. 2017. Panorama de la Seguridad Alimentaria en América Latina y el Caribe. Organización de las Naciones Unidas para la Alimentación y la Agricultura/Organización Panamericana de la Salud/Organización Mundial de la Salud. Santiago, Chile, 175p.

www.fao.org/paraguay/noticias/detail-events/en/c/428179

Contributions of Aquaculture to Rural Development in the Central American "Dry Corridor"

The *dry corridor* is an eco-region in Central American characterized by dry tropical forests. It includes the Pacific coastal areas, and most of the central pre-mountain region of El Salvador, Guatemala, Honduras, Nicaragua, Guanacaste in Costa Rica and Panama's Arco Seco. The area is distinguished by limited infrastructure and natural resources that securing continued access to suitable livelihoods for the population, and to ensure a minimal level of resilience, particularly in rural areas. As result, the population has a huge social dispersion, limited access to food, and the region is characterized by high rates of undernourishment (especially among children), poverty and migration to the larger cities or other countries.

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FAO has promoted rural development policies with a territorial approach through consultative processes, with the participation of different actors and users and implemented by the local governments. This approach has catalysed the integration and coordination between the governments and civil society and has led to better and more sustainable results in the field and has allowed the countries to confront the different problems in this zone.

National programmes to strengthen the aquaculture in the responsible institutions, and the inclusion of the sector in the planning of the Ministries of Agriculture have facilitated better coordination among public institutions and local governments, and have allowed aquaculture to become a key sector in local development.

In Guatemala, the National Programme for the Integration of Aquaculture into Family Agriculture (PRONIAAF) was developed by the Directorate of Fisheries (DIPESCA) into the Ministry of Agriculture and Livestock (MAGA), and has contributed to better coordinated plans such as the programmes for improved access to water for agriculture, programme for inclusive markets, public purchases, among others.

An example of this is the inclusion of aquaculture into a project for water access titled "Model for development Thismuntique village, making efficient use of water" it was developed by the local government in Chiquimula Guatemala with technical assistance of FAO. One of the main results was that the livelihoods of a high number of families was increased through Nile tilapia (*Oreochromis niloticus*) farming. In this programme,

two strategic approaches were followed: (1) Production of food for household consumption and (2) Strengthening farmer economy by selling surplus production. Nile tilapia was harvested after 3.5 months, with an average weight of 306 g and a survival rate of 90 percent. The fish were fed with a mixture of native tree spinach (local name chatate) (*Cnidoscolus aconitifolius*) and commercial feed (32-38 percent crude protein), which reduced feed cost of 40.2 percent. Out of the resulting fish production the household consumed 39.5 percent. While a programme of public purchases aiming at connecting small-scale farmers with the markets ensured that the remaining 60.5 percent were distributed among the local schools thus improving nutrition among school children. A cost-benefit analysis showed that for each US Dollar invested, the producer earned 0.26 (=1 USD). At the national level, a total of 336 families in Guatemala benefited from different programmes that integrate aquaculture in agriculture activities, and 127 families consume and market their products either in local markets or through public purchase programmes.

The National Plan for the Sustainable Development of Fisheries and Aquaculture of El Salvador developed with assistance from FAO, is being implemented by the Centre for the Development of Fisheries and Aquaculture (CENDEPESCA) within the overall framework of the Ministry of Agriculture and Livestock´s (MAG) Family Agriculture and Rural Entrepreneurship Plan for Food and Nutrition Security (PAF). In line with the strategic programme needs and opportunities, CENDEPESCA promotes polyculture of tilapia and whiteleg shrimp (*Penaeus vannamei*) as a strategy to optimize the sustainable use of natural resources, food production and income generation. This production system is implemented by the local governments in Atiocoyo Sur and San Isidro Cabañas. The producers now incorporate shrimp in what used to be tilapia monoculture. As a result, it was found that average income increased by as much as 28 percent due to the high value that shrimps have in the local markets. Furthermore, the price of shrimp is more resilient than that of tilapia, which is imported in large amounts from Honduras, and often saturates the market. This system allowed improve the incomes for producers making more economically attractive.

COURTESY: A. LÓPEZ

Fish farmers sell their products to neighbours

COURTESY: A. LÓPEZ

Children eating Nile tilapia produced in the fish farm of Thismuntique village, Guatemala

In general, the construction of public policies developed in consultation with users, governments and civil society, facilitates the interinstitutional collaboration and the implementation of programmes in the different territories. However, challenges remain to make aquaculture more resilient and sustainable in the Central American countries.

Blue Growth Initiative in Kenya: Increasing Knowledge for Informed Decision Making and Support to Farmers

FAO in collaboration with the Government of Kenya has developed two projects for the coast of Kenya with the aim of: (1) Increasing knowledge of the water basin that supplies coral reef ecosystem services that provide food, nutrition and livelihood security, the drivers of change affecting these services and their values, and technical and management options to improve ecosystem services, and (2) fostering investment in coastal sustainable mariculture and promoting an effectively governed mariculture development that is socially inclusive, equitable and environmentally responsible, and which provides opportunities for sustainable and profitable aqua farming as well as the economic activities that develop around it. This includes a better integration of the sector with other activities in the coastal zones and to increasing our understanding of and its role in conserving and improving coastal ecosystem services.

The work in Kenya, is one of the piloting pieces of work being carried out in support of the Blue Growth Initiative (BGI) designed around four streams of work: (i) capture fisheries, (ii) sustainable aquaculture, (iii) livelihoods and food systems and (iv) economic growth from aquatic ecosystem services.

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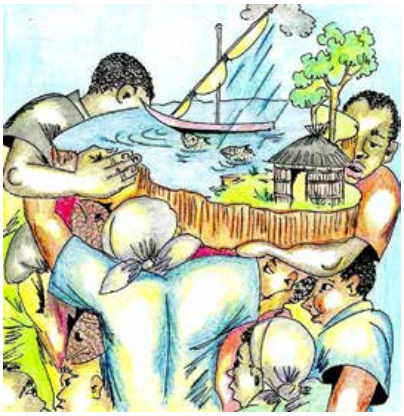
For the last two years, policy advisors and stakeholders that wish to invest in the coast of Kenya, especially in aquaculture and fish value addition activities, have benefited from a number of studies that have brought to light the ecosystem services and the drivers of change that affect those services and their values. The accumulation of knowledge of the project area ecosystem has highlighted the potential for economic and environmental activities such as fish processing and value addition, aquaculture, mangrove restoration and bee keeping and mariculture associated with ecotourism. The three studies are 1. Valuing Coastal Ecosystems as Economic Assets. The Mida Creek Report - Ecosystem Services and Biodiversity for Food and Nutrition Security; 2. Fish Value Chain – Appraisal of the Production and Post-Harvest Conditions in selected sites of Lake Victoria, Lake Turkana and the Marine Coast in Kenya; and 3. Spatial Planning – The Kenya Mariculture Project Atlas (under review for publication). All these products have facilitated better-informed policy and strategic advice to government and potential donors in the coast of Kenya.

These projects follow an intensive approach that combines environmental education in mangrove and ecosystem valuation, in doing aquaculture business within the FAO Ecosystem Approach, seaweed best management practices, etc.) with income generating activities. Throughout the project, especially during the studies and meetings associated with economic valuation of the ecosystem study for food security and nutrition, it was clear that environmental education alone, if not associated with income generating activities, would not persuade stakeholders to engage. Similarly, governments tend to dismiss projects that solely focus on conservationist interventions as they need to provide to the electorate with something that directly addresses poverty, food security and nutrition.

The training workshops, studies and meetings provided a vehicle for key stakeholders at local and national level institutions to interact, share ideas and learn about the value of their own ecosystems, the climate science and risk of endangering the potential to generate social and economic benefits. Once, the interpretation and analysis of the data collected in the studies were shared among all,



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it was much easier to convey the Blue Growth Initiative Key Objective of "*Supporting a more productive, responsible and sustainable fisheries and aquaculture sectors by improving the governance and management of the aquatic eco-systems conservation of biodiversity and habitats empowering communities (in particular the vulnerable communities engaged in small-scale production) to act, not only as resource users, but also as resource stewards*". Environmental and socio-economic activities were developed together to reach this goal, and now the Government of Kenya has formed a task force to review the Fisheries and Aquaculture legal framework and propose a single mariculture development strategy based on the Blue Growth principles.

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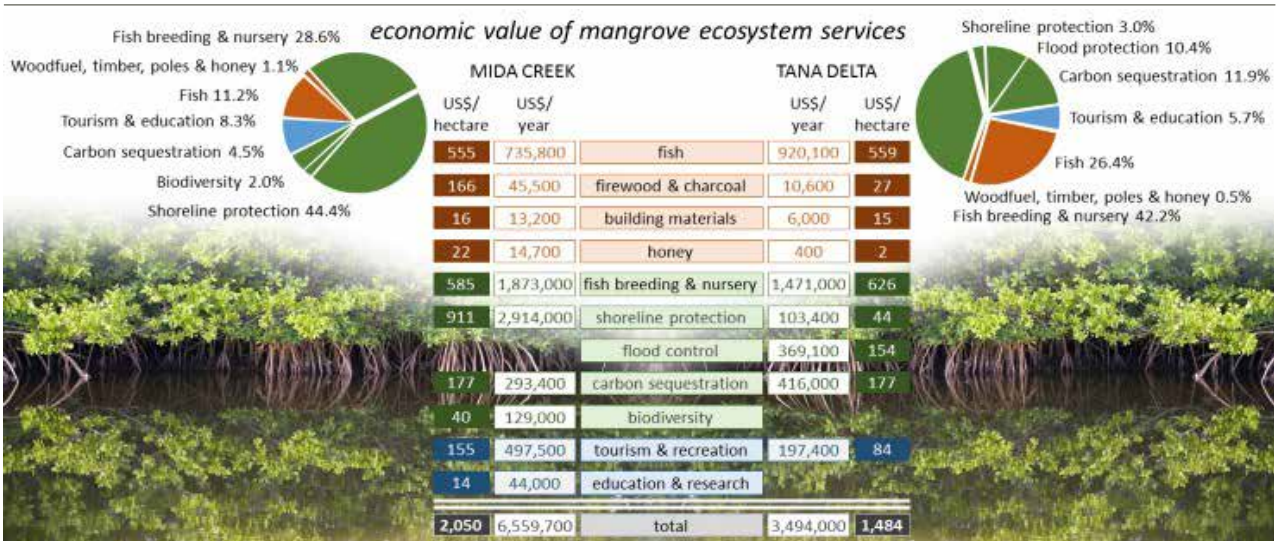
Group photo during the launching of the BGI in Kenya

The essential elements of implementing and piloting the Blue Growth Initiative pilot in Kenya, which are applicable to other countries in the sub-region, are:

- There is a need for similar kinds of initiatives, mixing normative work with development interventions in the field to promote knowledge exchange and provide practical training to those working in the field and at central level;
- The practical application of "mainstreaming" is challenging, and requires information, institutions and investments which are now being developed not only in Kenya but other countries in the sub-region;
- There is a crucial need for more practical evidence base and tools;
- There is a need to integrate and coordinate the various initiatives and agencies responsible for ecosystem value and services, climate change and development interventions;
- There is a need to create spaces and opportunities to encourage the exchange of experiences, disseminate results from studies and share knowledge around the challenges posed by the new BGI paradigm;
- There is a need for clear dialogue and integration of local and district/county needs in the development of programs and plans – so that the issues and challenges of these levels are properly reflected in the BGI papers which must be tailored to meet each region and country's specific needs.



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The economic Value of Mangrove Ecosystem services in Mida Creek and Tana Delta, Kenya, were calculate after community members had identified those services as being of the greatest importance to local food security and livelihoods

Sub-Regional Training Workshop on Doing Aquaculture as a Business

The Sub-Regional Training Workshop on Doing Aquaculture as a Business took place from 14 to 18 November 2016 in Addis Ababa, Ethiopia[1].

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Group photo of participants

The objective of the training was to enhance the capacity of both fisheries and aquaculture officers and farmers in developing their business acumen in order to facilitate the transformation of aquaculture in Africa into an economically vibrant and sustainable sector. The workshop aimed to help the participants to understand the technical and scientific principles of aquaculture, together with the economic and financial principles. A dedicated session introduced the concept of decent rural youth employment.

Forty-three participants attended the workshop from Burundi, Djibouti, Ethiopia, Guinea-Bissau, Kenya, Rwanda, Somalia, South Sudan and Uganda. The participants included nineteen farmers, sixteen government officers and eight FAO officers.

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The workshop was opened by the FAO Representative in Ethiopia, Mr Amadou Allahoury, and by the FAO Sub-regional Representative for Eastern Africa and FAO Representative to AU and UNECA, Mr Patrick Kormawa.

Participants were first introduced to the technical principles of doing aquaculture as business. The main elements included factors affecting productivity and carrying capacity in water, growth rate, and yields. This was followed by sessions on the fundamental principles of economic and finance. The participants were trained on how to assess the economic profitability and financial feasibility of aquaculture farms by introducing them to the prototype of the FAO "User-Friendly Tool for Investment Decision Making in Aquaculture", developed by the Aquaculture Branch of the FAO Fisheries and Aquaculture Department and the FAO Sub-regional Office for Eastern Africa. A beta version of the Tool will be shortly released online. The Tool is targeted to assist small- and medium-scale fish farmers in their decision to invest or not in aquaculture under specific assumptions. During the training, topics such as youth employment challenges and solutions, and practical tools to promote decent rural employment for youth were also explored.

Conducting the technical and business training together proved to be a successful training model. Pairing these topics reinforced their mutual reliance and importance for the participants. At the end of the training participants were able to independently use the Tool and select the most pertinent factors for conducting aquaculture as a business.

1 The 5-day training was held under the FAO Multi-partner Programme Support Mechanism (FMM) to the Blue Growth Initiative (BGI) in "Support of Food Nutrition Security, Poverty Alleviation and Healthy Oceans" and the FAO Africa Solidarity Trust Fund (ASTF) project "Promoting Agricultural Diversification to Reduce Poverty, Fight Malnutrition and Enhance Youth Employment Opportunities in Eastern Africa".

Is Aquaculture a Logical Choice for Youth Employment? Lessons Learnt from a Project in Liberia

This article describes an interesting collaboration developed in Liberia between the Ministry of Youth and Sports (MYS) and the FAO Representation. Generally, FAO collaborates with ministries responsible for the agriculture sector, but this time FAO was approached by MYS in 2014 for the elaboration of a Technical Cooperation Programme (TCP) to create aquaculture enterprises for youth employment, poverty reduction and food security, with a budget of USD 492 000. The completion date was supposed to be in December 2015, but extensions were authorized until December 2016 as Liberia went through a serious Ebola crisis, during which all project activities came to a standstill and were only resumed in the course of 2016. In the second half of 2016, an attempt was made to catch up with time. Prior to the Ebola epidemic, national consultants were used to conduct training in the fields of pond digging and maintenance, fish growth and all the other relevant aspects of rearing fish in earthen ponds, in close collaboration with staff from the Government's fish breeding center in the town of Klay. The

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Liberian youth harvesting tilapia from a fish pond

two species selected were Nile tilapia (*Oreochromis niloticus*) and African arowana (*Heterotis niloticus*). Four excellent sites had been selected, numerous ponds dug and tilapia broodstock released. During that crisis period, no backstopping missions could be carried out, so the fish were basically left on their own, although some youths living near the ponds continued to feed the fish with wheat bran. When the country was declared Ebola free the TCP picked up steam and training of the youth continued and courses taught. Backstopping started and for the entire duration of the project, no test fishing was carried out. Draining of the ponds resulted in a complete absence of the broodstock, some fish of around 100 grams each and many thousands of fingerlings. Breeding had been apparent from the nest pits also. The conclusion was that all brooders had disappeared due to the completely open access to the fish farms (which resulted in poachers catching the fish), despite the actions of farm guards. Hardly any fish growth could be observed as the only feed was wheat bran. The leftover funds in the project allowed fencing of the cooperative farms, installation of security lights, and purchase of extra ingredients to improve feed (including a considerable portion of the thousands of harvested fingerlings).

The project started off with a total of 150 youths and just before the project closure only 34 remained. Others abandoned the project as there was no fish to be harvested and thus no income generated. Obviously, the implementation of the project was not without

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hurdles, but still some lessons can be learned from a situation where aquaculture is introduced to youngsters, who as a result were supposed to gain decent employment. Some of the lessons learnt could be summarized as follows:

– Supervision of the activities of the youth should have been more intense; training of the youngsters ought to have been phased instead of being provided in a compressed period;
– The youth had been digging ponds but particularly during the first production cycle there was no income, therefore, additional activities generating some revenues should have accompanied the project;
– The feed provided by the project was of lower quality and did not adequately improve fish growth;
– Harvesting of the project's broodstock was not foreseen and as such new investments had to be made.

It should be noted that this article has been prepared in a constructive spirit and without blame being attributed to any project stakeholder.The experience in Liberia is not unique. Other countries in the sub-region shared similar experiences. This TCP project should have made the youth enthusiastic for aquaculture activities; instead they became disenchanted. We can only say that, based on lessons learnt, next time we will perform better.

Rice-Fish Farming in the Malagasy Highlands, Twenty Years after the FAO Projects

According to Madagascar tradition, rice-fish farming started when Queen Ranavalona decided to release in the wild the seven goldfish (*Carassius auratus*) that had been introduced in the country for her amusement. Whether this is a legend or the reality, Madagascar has an old tradition of farming aquatic species, and it is today a significant aquaculture producer, with a reported production of 3 763 tonnes of freshwater fish, 4 696 tonnes of shrimps and 8 363 tonnes of seaweed in 2014. Goldfish, locally called *Tondro Gasy* ("The Malagasy fish") is still considered the national fish, but common carps (*Cyprinus carpio*) and several species of tilapias (*Oreochromis* sp. and Tilapia spp.) overpassed it in the production statistics. This is mainly due to the FAO support projects implemented for more than a decade from the mid-1980s to the mid-1990s, and from the successive development projects that followed. However, the potential of the country is still largely untapped, particularly in the inundated rice fields, which currently represent the main freshwater producing system.

In Madagascar, the active promotion of aquaculture started at the beginning of the twentieth century. Tens of thousands of ponds were built until the 1950s, as well as several governmental fish farms supplying fry, developing new technologies and contributing to capacity development. Following an early, now-disputed, assessment that the Malagasy aquatic fauna had a limited-to-no potential for fish production, a significant number of exotic species have been introduced in the country from the tropics but also from the temperate regions for stocking in the colder highlands where most of the Malagasy population lives. It started in 1857, with the giant gourami (*Osphronemus goramy*) and in 1861 Jean Laborde offered seven goldfish to Queen Ranavalona, in what tends to be considered as the starting point of rice-fish farming development in the country. Since then many other species have been introduced, including the common carp (*Cyprinus carpio*) and several species of tilapias (*Oreochromis* spp. and *Tilapia* spp.) that now dominate the national production with respectively 69 and 31 percent of the total freshwater fish production in 2014.

Whereas the traditional rice-fish farming based on self-recruiting species was silently spreading in the rural areas, pond aquaculture largely failed in becoming sustainable in the

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Photo 1 - Rice field stocked with carps

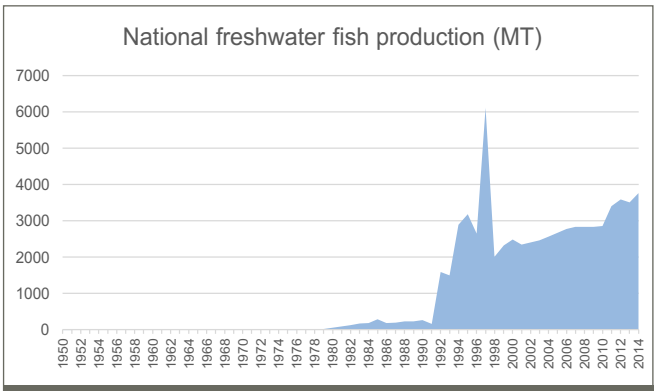

Figure 2 - National freshwater fish production

absence of subsidies from the government. Starting from 1985, FAO implemented a series of projects that completely changed the situation. Instead of promoting fish pond farming, they focussed on improving the traditional rice-fish integration. New technologies where developed and promoted, by stocking common carps instead of wild fish, by digging a refuge canal and by strengthening the side dykes (Photo 1), reportedly allowing to produce up to 200-300 kg of fish per hectare while increasing rice yields by 10 to 30 percent. The involvement of the private sector for supplying the fry market was also promoted. All these activities had a major impact on the national fish production (Figure 2) that increased 10 to 15 folds, from 200 tonnes before 1990 to over 2 500-3 000 tonnes/year a decade later.

Several National and International initiatives followed. Some were focusing on tilapia production through the establishment of partnerships between the Ministry of Fisheries (MPRH) and National institutions like FOFIFA[1], or through International partnerships with nearby Reunion island (ARDA[2]), Japan (PATIMA[3]-JICA[4]), Norway (MIDEM[5]-now "Tilapia de l'Est") or European Union (APDRA[6]). Others were rather concentrating their efforts on carps in integrated rice-fish systems (APDRA with France, EU or the Indian Ocean Commission's Smartfish project).

One issue quickly emerged in relation to the fry market. FAO's projects had contributed to implement a network of hatcheries, locally called PPA (Private Producer of Fry, Photo 3) but in the meantime, small Peasant Hatcheries (EP, Photo 4), were spontaneously established to fill a commercial gap: the small rice-fish farmers who were only able to buy and stock a few tens of fry. In some places, EPs became so numerous that they supported a very competitive fry market, like the case of the small rural town of Betafo (Photo 5) where the supply is now so good that the price of a piece of fry can be as low as 30 ariary[7] when the average in the Malagasy highlands reached 100 to 300 ariary per piece in remote areas. Although spontaneous and probably old, EPs emergence was controversial at first, as they were seen as unfair competitors to the larger PPA. Moreover, there was the fear that they would not have the capacity to maintain good genetic quality, although they were implementing Best Management Practices such as exchange of breeders, or the use of internationally recognized criteria for fish selection, etc. However, a genetic assessment showed that there was no inbreeding and the

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Photo 3 - A large PPA farm

1 Foibem-pirenena momba ny Fikarohana ampiharina amin'ny Fampandrosoana ny eny Ambanivohitra (www.fao.org/documents/card b41ee223b)
2 Association Réunionnaise pour le Développement de l'Aquaculture, now known as Hydro Réunion
3 Projet d'Aquaculture de Tilapia à Mahajanga
4 Japan International Cooperation Agency
5 Mission Indépendante pour le Développement et l'Éducation à Madagascar
6 Association Pisciculture et Développement Rural en Afrique
7 1 USD=3000 ariary

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Photo 4 - A small EP farm, with breeding ponds dug inside the rice terraces

PPAs finally accepted that they were not that much adversely impacted, as most of them were interested in selling larger volumes of fry. Both now peacefully coexist by targeting their different markets.

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Photo 5 - The carp fry market in Betafo

In recent years, the Malagasy government has been working on creating an enabling environment for aquaculture, by elaborating a new strategy for its development and by implementing a new legal framework for the sector. However, the fish farming production potential still remains largely unexploited despite a very high market demand. Indeed, ponds and cages aquaculture is still incipient, and APDRA reports that another 150 000 to 200 000 ha of appropriate rice fields would still be available for fish production in the highlands. For integrated rice-fish farming, the current main limitation is represented by the local availability of common carp fry to farmers and the effort made by the ministry, together with APDRA and influent local professional organizations like MPE[8] or FMTMA[9], are supporting the establishment of new hatcheries, trainings for farmers, strengthening an enabling environment and implementing aquaculture networks within a value chain approach.

Furthermore, for ponds, cages, and intensive production systems, the low availability of good & affordable feed and fertilizers may be another constraint. This issue has been successfully tackled by PATIMA/JICA by promoting integrated animal-fish production, and by MIDEM/"Tilapia de l'Est" through a partnership with the Asian Institute of Technology and Nam Sai Farm (Thailand) to use in Madagascar tilapia farming technologies that proved successful in Asia. But still, in spite of several successful experiences throughout the country, the further upscaling of the existing aquaculture industry remains problematic and non-availability of affordable quality fish feed on a large scale is probably one of the reasons.

8 Malagasy Professionnels de l'Élevage
9 Fikambanan'ny Mpiompy Trondro Eto Madagascar

SEE ALSO

www.jica.go.jp/madagascar/french/office/others/publications01.html
http://tilapiadelest.com
http://apdra.org
www.fao.org/fishery/countrysector/naso_madagascar/en
www.fao.org/madagascar

Many documents on Madagascar aquaculture are available on:
FAO publications on Madagascar:
www.fao.org/fishery/publications/search/en

Three videos introducing Madagascar aquaculture in rice fields, cages and ponds (in French):
http://uved-formation-aquaculture.cirad.fr/03-les-systemes-de-production/pour-en-savoir-plus

A detailed description of current rice-fish farming development and research in Madagascar (in French):
www.coopuniv-frmg.org/index.php/2016/11/25/sortie-de-louvrage-recherche-interdisciplinaire-pour-le-developpement-durable-et-la-biodiversite-des-espaces-ruraux-malgaches/

Several case studies on aquaculture in Madagascar:
www.sarnissa.org/

Florence Wallemacq. 2016. Fish farming in rice field: Development lever for family farming in Madagascar. *FAO Aquaculture Newsletter.* March 2016 No. 54: pp. 38-39. **www.fao.org/3/a-bc866e.pdf**

A new area of interest in Madagascar is represented by species diversification. If some investment has been made on introduced species like developing tilapia farming in the highlands' cold climate or implementing a sturgeon farm in Mantasoa for caviar production, there is also a renewed interest in exploiting the indigenous fish, either for the ornamental (APPA) or food market. FOFIFA is for example working on marakely (*Paratilapia polleni*), one of the most promising local species, to determine its potential in fish pond or rice field polyculture with carps and/or tilapias.

FAO implication in Madagascar's fish farming started in 1976 with project MAG/76/002 on capacity building and strengthening of the Ministry of Fishery but it is a decade later that the majority of its support was transformed into concrete initiatives, with a series of development projects (MAG/82/014, MAG/86/005, MAG/88/005, MAG/92/004, MAG/058/6023) focusing on rice-fish farming. In 2003, a Telefood project was also granted to provide equipment to fry producers, whereas in 2005, FAO supported the Government in establishing its National Strategy for Marine and Inland Aquaculture Development. Since 2014, the Indian Ocean Commission's Smartfish project has also been supporting rice-fish farming (Figure 6).

In a country like Madagascar with abundant water resources but that also faces major natural and human challenges, such as low temperature in the highlands, cyclones, drought, poverty or rural insecurity, freshwater aquaculture is already fulfilling a major role in food security, nutrition, income generation and livelihood in rural areas. It could do more, considering that some immediate deadlocks were already removed. If profitability of existing aquaculture ventures could be improved and adequate technologies be developed for fish pond systems, the perspectives for Madagascar aquaculture would then be bright.

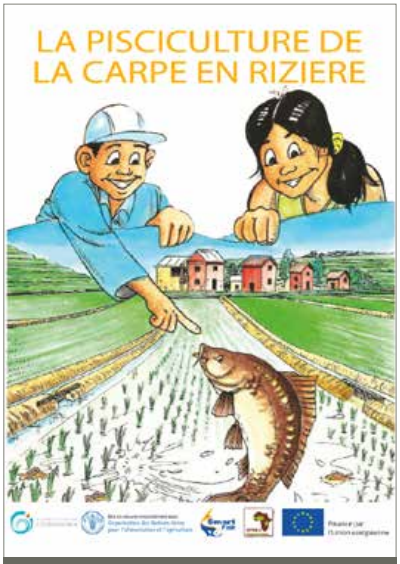

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Figure 6 - A comic book funded by the Indian Ocean Commission's Smartfish project on rice-fish farming

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Sixth Annual Meeting of the Aquaculture Network for Africa (ANAF)

The Aquaculture Network for Africa (ANAF) is an informal network launched in 2006 following a decision taken at the 14th Session of the Committee for Inland Fisheries and Aquaculture (CIFAA) held in Accra, Ghana, in November of the same year, to establish a "NACA-Like" network. ANAF was launched with four Members, which has now increased to fourteen participating countries. Expansion of the network to other countries is still ongoing, promoting institutional strengthening to ensure sustainable aquaculture development, maximising its potential to improve regional food security and nutrition in sub-Saharan Africa.

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Group photo of participants

ANAF National Focal Points which represent their countries at the annual meetings, had already met several times to discuss common aquaculture issues, to elaborate a work plan and to define ANAF-Intergovernmental Organization (IGO) transformation process.

Through the assistance of FAO, a web-based information system has been developed, which is currently hosted by the Lake Victoria Fisheries Organization (LVFO) in Jinja, Uganda. The information system was established to generate, disseminate and facilitate the access of aquaculture information to ANAF Member countries.

The Sixth ANAF Annual Meeting was held at the Imperial Golf View Hotel, Entebbe, Uganda from 6 to 9 December 2016. The meeting was funded and organized by FAO with the assistance of the Lake Victoria Fisheries Organization (LVFO) and the Ugandan Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). The meeting was attended by: Legal Officers from Chad, Kenya, Liberia, Mali, Nigeria, Senegal, Tanzania, Uganda, Mozambique and South Africa; the ANAF National Focal Points from Cameroon, Kenya, Senegal, South Africa, Zambia and Uganda; one representative from the African Union-Interafrican Bureau for Animal Resources (AU-IBAR); one FAO Legal consultant; the Senior Fisheries and Aquaculture Officer from the FAO Regional Office for Africa in Ghana; one Aquaculture Officer from FAO Headquarters in Rome; the Executive Secretary and two Technical Officers from the Lake Victoria Fisheries Organization (LVFO). Overall, 12 out of 14 ANAF member countries were represented at the meeting. The purposes of the meeting were to: (i) review the commitment to ANAF by its member countries; (ii) discuss and revise the draft of four IGO founding legal documents; and (iii) to discuss and agree on a clear strategy and concrete follow-up actions leading to the formal establishment of ANAF.

During the meeting, two working groups were established. The Legal Officers working group that reviewed ANAF legal documents which included the Draft Agreement, the Draft Rules of Procedure, the Draft Financial Regulations and the Draft Headquarter Agreement. The second working group composed by ANAF National Focal Points elaborated a concept note on the roadmap for the establishment of ANAF. Two options were proposed to formalize ANAF: (1) the ANAF secretariat to be hosted by a member country as an IGO; or, (2) Integration of ANAF as a unit within the AU-IBAR structure. The meeting was more in favour of the second option for budgetary reasons, but a final decision will be taken by member countries during the next CIFAA Session to be held in the Gambia the 7–9 May 2017.

Mali offered to host the Seventh ANAF Annual Meeting in 2017. South Africa also offered to host the next ANAF meeting back-to-back to the World Aquaculture Society meeting to be held in Cape Town during 26–30 June 2017. This could be a good opportunity to promote ANAF at the international level.

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SEE ALSO

FAO. 2017. Report of the Sixth Aquaculture Network for Africa (ANAF) Annual Meeting. Entebbe, Uganda, 06–09 December 2016. FAO Fisheries and Aquaculture Report. No. 1187. Rome, FAO.
www.fao.org/3/a-i7015e.pdf

Lake Victoria Fisheries Organization
www.lvfo.org

Overview of Ornamental Species Aquaculture

Ornamental aquaculture is a growing industry and it will become more and more important as restrictions are placed on collecting species from wild environment.

Ornamental fish trade is a widespread and global market, moving large amounts of goods and money (Wabnitz *et al*., 2003) offering services and job opportunities to new professionals, and contributing to the economic growth of undeveloped countries.

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Future challenges raised by this trade concerning environmental and social issues need to be addressed in particular:

- Conservation and sustainable use of ornamental fish species
- Reduce habitat loss and degradation
- Implementation of renewable and sustainable fishing practices
- Regulation of international trade patterns
- Reduction of alien exotic species dispersal.

The total ornamental fish industry is valued at approximately USD 15 billion and global exports of ornamental fish has grown from USD 181 million to USD 372 million between 2000 and 2011. Freshwater fish have an estimated price per pound of 35 to 60 USD while marine fishes price per pound is estimated 400 to 600 USD. In addition, corals play a big role in the industry. Live coral trade has increased tenfold since 1985 and continues to increase 20 to 30 percent each year. The major exporter in the world is Singapore; in 2013 alone exported goods worth 56 USD millions to more than 80 countries.

After 30 years of aquarium trade, the total value of aquarium exports from the Pacific region is currently accounting for about 10-15 percent of the global trade. This trade has now become an important source of income and employment for local communities in the Pacific.

The majority of the aquarium species are imported in the USA, followed by Europe, Japan, and a handful of other countries. Currently, approximately 90 percent of freshwater traded organisms in the ornamental fish industry are cultured. Less than 10 percent of marine species are cultured. At least 85 percent of marine aquarium fish sold to the USA is collected from the Coral Triangle Region, represented by the waters of the pacific countries of Indonesia, Malaysia, Papua New Guinea and the Philippines. Total global annual catch could range from about 14 million to

over 30 million fish. The most recent estimates suggest that the trade targets over 150 species of stony corals, hundreds of non-coral invertebrates, and at least 1 472 reef fish species from 50 families.

Harvesting species from the wild creates both direct and indirect environmental issues such as:

- Destructive techniques utilized to collect animals. Among the destructive practices is the illegal use of cyanide, which poachers often use to stun the fish and make them easier to capture. This practice not only causes toxic effects that leads to high mortality on the collected animals, but also destroys the fish habitats.
- Biodiversity loss due to the over-harvesting of targeted organisms.
- Risk of introductions of alien exotic species and/or diseases (such as Koi herpes virus) in the targeted areas.
- High levels of mortality associated with insensitive shipping and poor husbandry practices through the supply chain.

Ornamental aquaculture is targeted as one of the main possible tools, to reduce overfishing along coral reefs. Furthermore, it can provide healthier animals, with higher resilience for survival in captive conditions reducing the risks of disease spread.

While a majority of aquaculture production worldwide is devoted to food production, ornamental fish production is an important component of the aquaculture sector in several nations. In Singapore, ornamental fishes accounts for 40 percent of their total exports. In the USA, ornamental fish production is the fourth largest sector behind catfish, trout, and salmon with Florida producing approximately 80 percent of the total value.

Most of the aquaculture production of ornamental fish focuses on freshwater species. In the USA, aquaculture facilities in Florida produce 800 varieties of freshwater fish.

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Culture of *Acropora* corals in Solomon Islands

On the other hand, only about 25 species of marine fishes (1-10 percent) are cultured on a commercial basis. Aquaculture, however, is providing the market with an increasing variety of cultured products. For example, giant clam farming has increased since the first trials in the 1980s; in 2007, over 75 000 cultured clams were exported from the Pacific. Cultured corals and live rock are also being successfully sold to environmentally conscious aquarists.

Even though aquaculture can help sustains the ornamental fish industry and restore threatened wild populations, there is still very little information available. Indeed, better industry monitoring and data reporting is needed.

Recent and updated data about ornamental fish trade can be found in FAO Fishstat database and UN Comtrade Database that provide global trade data; OATA (Ornamental Aquatic Trade Association) provides European trade data. FAO is the only organization that make a distinction between freshwater and saltwater fishes. Data collection and dissemination is a key element for monitoring the status and trend of ornamental fish culture, if volume and diversity of trade are better known, it will be possible to tackle other relevant issues that can lead to environmental and economic benefits. More efforts for the sustainable management of this industry are needed such as:

- Promote data collection efforts on ornamental fish trade.
- Enforce correct invoice documentations with accurate data on shipment contents.
- Distribution of educational manuals and guidelines to collectors, exporters, importers as well as retailers and aquarium keepers.

Further research in developing breeding protocols for raising commonly traded species represent an opportunity to produce healthier and more resilient species to captive conditions, to improve livelihoods in developing countries and to take pressure off wild stocks protecting the environment.

C. Wabnitz, M. Taylor, E. Green, T. Razak. 2003. From Ocean to Aquarium. UNEP–WCMC, Cambridge, UK (2003).

R. Calado, I. Olivotto, M.P. Oliver & G. Joan Ho. 2007. Marine Ornamental Species Aquaculture. John Wiley and Sons Ltd. 712 pp.

Improving the Technical and Economic Performance of Tilapia Farming under Climate Variation from a Bio-Economic Modelling Perspective

The FAO Fisheries and Aquaculture Department has been providing technical assistance to help fish farmers adopt practices that increase and improve aquaculture production in a sustainable manner. As part of this assistance, a bio-economic model on intensive pond aquaculture of tilapia (one of the most popular aquaculture species) has been developed based on experiences in China (the largest tilapia farming country). A main component of the model is a tilapia growth function calibrated from empirical data in China. The growth function captures the impacts of farming environment (e.g. water temperature) and farming practices (e.g. stocking density, feeding regime, etc.) on tilapia growth. Based on the growth function, technical factors (e.g. stocking timing and density, fingerling size, etc.) and financial factors (e.g. feed, seed and other input prices, fish price, etc.) are added to the model to simulate the impacts of climate, technical and/or financial factors on farming performance and to examine the performance of various farming practices.

The simulation[1] results indicate that farming practices such as selection of stocking timing, fingerling size, stocking density, feeding regime and/or harvesting timing could have significant impacts on the technical and economic performance (e.g. productivity and profitability) of tilapia farming. Two selected simulation results are briefly described below:

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Impact of stocking timing on farm performance

Given a specific feeding regime that determines feeding amount based on fish body weight and water temperature, the maximum annual profitability for one-year-two-crop arrangements that stock 1g fingerlings is 92,491 Chinese Yuan (CNY)[2], which, as illustrated by the orange dotted lines in the figure below, would be achieved by a 22-week 1st crop from 09-April to 10-September (stocking 1 g fingerlings at the density of 1 700 fish/mu or 25 500 fish/ha) and a 26-week 2nd crop from 14-September[3] to 26-March the next year (stocking 1 g fingerlings at the density of 2 000 fish/mu or 30 000 fish/ha). If the farmer chooses to start the 1st crop on 18 June (represented by the blue dot lines in the figure), which is the worse stocking timing that would lead to the minimum profitability, the overall, annual profit achievable for a one-year-two-crop arrangement would be only 78,137 CNY (16 percent lower than the maximum profitability for one-year-two-crop arrangements) even with optimal adjustments of stocking density and crop length.

Maximizing the profitability of individual crops ≠ Maximizing the overall profitability

Another insight from the simulation results is that farming practices that maximize the profit of individual crops may not maximize the overall profitability because of path dependency (i.e. performance of an individual crop is dependent upon farming arrangements in previous crops) of farming performance. For example, suppose a farmer stocks 18 000 1 g fingerlings in a 1 ha pond on 29 May, then the most profitable arrangement for this crop (in terms of profit per week) would be a 22-week cycle (i.e. harvesting on 30 October), which would yield 1,721 CNY per week and 41,294 CNY in total. After 2-week pond preparation, the farmer can start the 2nd crop on 13 November with the same stocking density and fingerling size, the most profitable arrangement in the 2nd crop would be a 26-week cycle (i.e. harvesting on 15 May), which would yield 931 CNY per week and 26,057 CNY for the entire 2nd crop. Note that the duration of the two crops (48 weeks in total) plus 4 weeks for pond preparation before each crop is equal to 52 weeks (i.e. a year), which implies that the two crops can repeat year by year.

1 The simulations are conducted in STATA (a statistical software) and Microsoft Excel.
2 The exchange rate of CNY during the study is 1 USD=6.5 CNY
3 There is two-week pond preparation before starting the 2nd crop.

While the arrangements in both crops are profit maximizing for their individual crops, their combined profit (i.e., 67,351 CNY[4]) is nevertheless not maximizing the annual profit. The reason is that while the arrangement in the 1st crop maximizes the profitability in the current crop, it nevertheless results in a less opportune stocking timing for the 2nd crop.

If the farmer shortens the 1st crop to 21 week, the 1st crop profit would drop 2 CNY to 1,719 CNY per week. However, the one week less in the 1st crop could allow the farmer to start the 2nd crop one week earlier and have it one week longer, which would increase the profitability of the 2nd crop to 986 CNY (55 CNY higher than that in the original arrangement). As the gain in the 2nd crop would exceed the loss in the first one, the annual profit of the latter arrangement (68,141 CNY) would be higher than the original one that maximizes the profitability in the individual crops separately. The merit of this example is that the potential performance of a crop is affected by the arrangement of previous crops (i.e. path dependency); hence farmers should take a holistic approach to maximize annual profit instead of maximizing the profitability of individual crops.

Other salient results

Other notable results of the simulation include: (i) given no price discrepancy against small size fish, harvesting at about 300 g in two-year-five-crop arrangements could increase the overall profitability by up to 50 percent compared to harvesting above 500 g in one-year-two-crop arrangements and (ii) a two-tier farming system that separates nursing and outgrowing ponds could allow one-year-three-crop arrangements that enhance profitability by up to nearly 90 percent compared to the one-year-two-crop arrangements and by up to nearly 30 percent compared to the two-year-five-crop arrangements.

Way forward

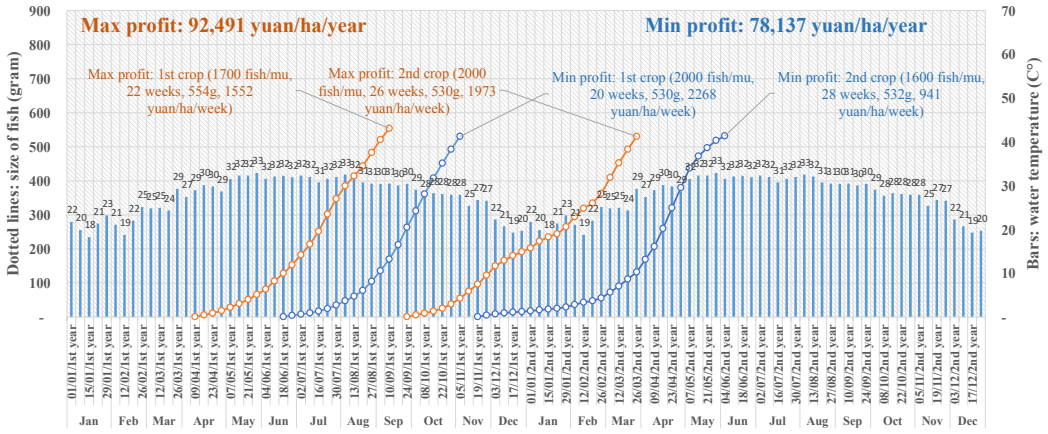
The bio-economic model and its results indicate that bio-economic modelling has great potential in improving aquaculture performance. The model has been presented at the International Institute of Fisheries Economics and Trade (IIFET) Conference in 2016 and will also be presented at the World Aquaculture conference in 2017. They will be document in a technical paper expected to be published in the late 2017 or early 2018.

Development of bio-economic models on aquaculture entails close collaboration among fish farmers, researchers and policymakers. FAO welcomes collaboration in this endeavor.

With more refined information on fish growth under different farming conditions, the model could be tailor-made into decision-making tools to help farmers design optimal farming arrangements. For example, user-friendly, spreadsheet-based templates can be developed to help farmers compare the performance of different farming arrangements and make decisions accordingly. The FAO Fisheries and Aquaculture Department has on-going activities in developing bio-economic models to help fish farmers in Africa improve farming performance.

Related comments, suggestions and inquiries can be sent by email to the author of this article.

One year two crops: max vs. min profitability



In this figure the bars represent water temperature in different weeks; dotted lines represent the growth of fish body weight under different arrangements. The profitability of the two farming arrangements are highlighted.

4 This is lower than the minimum profitability for one-year-two-crop arrangements shown in the figure (i.e. 78,137 CNY) because, for simplicity, in this case the farmer is assumed to fix the stocking density at 1 200 fish/mu; whereas in the cases shown in the figure the farmer has flexibility in selecting stocking density.

A Case for Fish to Lead Greater Food Security and Nutrition Outcomes

If done right, fisheries and aquaculture can provide nutritious food for all and generate decent incomes, while supporting people-centred rural development and protecting the environment. Fish is widely looked to as a nutrient-dense food containing high quality protein (readily digestible, with essential amino acids) and long-chain polyunsaturated fatty acids and micronutrients, but has only recently been recognized as having "*... a special role in nutrition and health*". The fisheries sector is crucial to food and nutrition security, and its importance is growing: people have never consumed as much fish nor depended so much on the sector for their livelihoods. Of the 30 countries most dependent on fish as a protein source, all but four are in the developing world. To maximise potential of fish to contribute to national policies towards economic, social and environmental goals, we must analyse and clearly communicate the role fish can play in food security and nutrition. To this end, FAO engages an intradepartmental technical group on fish, food security and nutrition, connecting sectors which together can support sustainable fisheries practices and improved nutritional and food security outcomes.

Food security and nutrition has risen to the top of the global political agenda, and stands as Goal 2 of the Sustainable Development Goals, to "*end hunger, achieve food security and improved nutrition*". This focus is essential as one in nine people in the world today are undernourished, with poor nutrition causing 45 percent of deaths in children under five years old[1]. If done right, fisheries and aquaculture can provide nutritious food for all and generate decent incomes, while supporting people-centred rural development and protecting the environment.

Fish is widely looked to as a nutrient-dense food containing high quality protein (readily digestible, with essential amino acids) and long-chain polyunsaturated fatty acids and micronutrients, but has only recently been recognized as having "*... a special role in nutrition and health*"[2]. The fisheries sector is crucial to food and nutrition security, and its importance is growing: people have never consumed as much fish nor depended so much on the sector for their livelihoods[3]. Of the 30 countries most dependent on fish as a protein source, all but four are in the developing world[4]. In many of the least developed countries of Africa and Asia, fish accounts for more than half of the total animal protein intake for food insecure populations.

Fish products and other aquatic foods (including seaweeds, molluscs, crustaceans, fish, and

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Increasing nutrition through sun-drying fish in Somalia

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1 www.un.org/sustainabledevelopment/hunger/
2 International Conference on Nutrition (2014).
3 FAO 2014. Improving Diets and Nutrition: Food-based Approaches (eds B. Thompson and L. Amoroso).
4 www.fao.org/FOCUS/E/fisheries/intro.htm

amphibians and reptiles) are a central and natural source of essential nutrients such as long chain omega-3 fats essential for optimal cognitive development in children. Micronutrients such as iron, zinc, iodine, calcium, selenium and even vitamin A can be obtained through various fish products, particularly when fish is eaten whole, such as the case with small pelagic fish. In larger fish, the levels of these micro-nutrients are high usually found in parts that are not eaten, such as heads and bones. By using innovative approaches and available technologies, valuable nutrients could be made available for human consumption and waste could be cut. Such low cost fish by-products have the potential to play an important role in achieving nutrition and food security where these gaps persist.

Within the Fisheries sector, aquaculture's contribution to food security is of particular interest, as until recently it has been the fastest growing food-producing sector in the world[5]. It is critical to promote food security through aquaculture in a sustainable way, especially considering a great proportion of this production comes from the developing world (91.2% in 2000), in particular Low Income Food Deficit Countries (LIFDCs) (83.9% in 2000).

Despite its prominence in the diets of the poor (especially internally displaced persons and coastal communities), fish has remained in the margins of global discussions on food security and nutrition policies. During the Second International Conference on Nutrition (ICN2), world leaders and member states committed to eradicating hunger and preventing all forms of malnutrition worldwide. FAO's food-based approach includes food production, dietary diversification and food fortification, and thus increased consumption of fisheries products can be used to combat most of the major micronutrient deficiencies.

To maximise potential of fish to contribute to national policies towards economic, social and environmental goals, we must analyse and clearly communicate the role fish can play in food security and nutrition. To this end, FAO has recently engaged an intradepartmental technical group on fish, food security and nutrition, connecting sectors which together can support sustainable fisheries and aquaculture practices and improved nutritional and food security outcomes.

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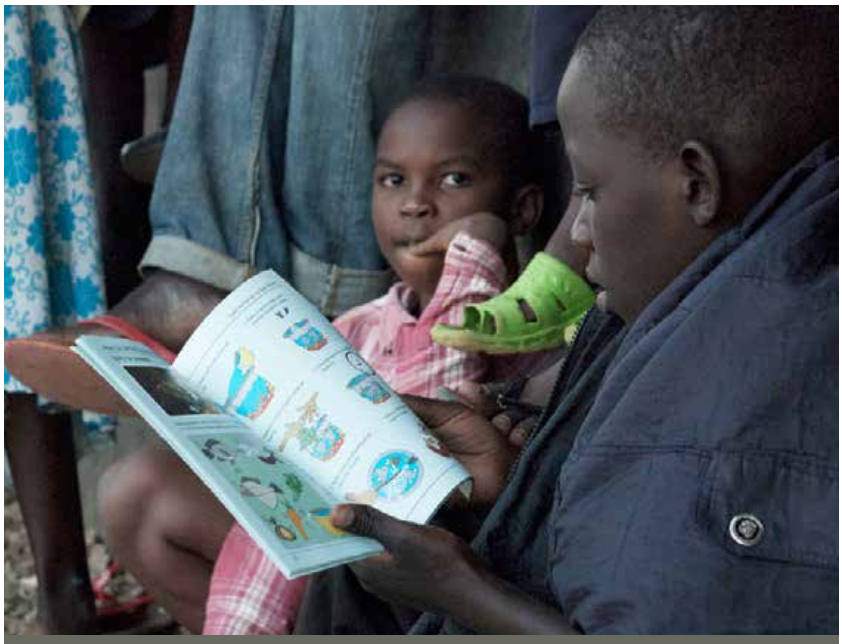
A good source of protein, minerals and vitamins, fish is especially important for pregnant women, infants and children, and the elderly



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Children in Tanzania reading the Cooking Freshwater Fish recipe book in Swahili

5 Béné *et al.* 2015. Feeding 9 billion by 2050. Putting fish back on the menu. Food Security 7, 261-274. https://link.springer.com/article/10.1007/s12571-015-0427-z

The Potential of World Aquaculture Performance Indicators as a Research and Educational Tool

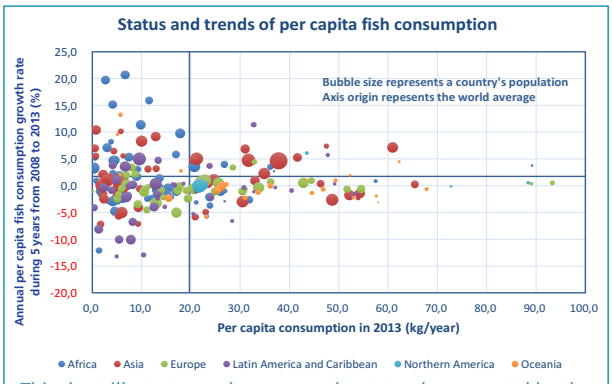
FAO has continued its efforts in developing World Aquaculture Performance Indicators (WAPI) to assess the economic, social and environmental performance of the sector. WAPI is an on-going initiative to develop a tool to compile, generate and disseminate knowledge and information for evidence-based policy-making and sector management in aquaculture and aquaculture value chains[1]. Under this initiative a WAPI prototype has been developed and tested. The prototype contains sample templates on fish production, trade and consumption as well as other social, economic and environmental aspects of aquaculture at global, regional and/or national levels. Based on the prototype, two tailor-made WAPI modules, one on fish production and the other on fish consumption, will be disseminated for public use by the end of 2017. Five technical papers that would serve as background documents for WAPI modules on various subjects are being prepared and will be published during 2017–2018[2].

While the ultimate goal of WAPI is to provide a tool to facilitate evidence-based decision making, its potential of becoming a research tool has become evident during its development. WAPI templates developed in Microsoft Excel[3] could initially help researchers analyze data, generate information and later facilitate result dissemination. For example, the chart below is a figure generated by a WAPI template for the paper "Assessment and monitoring of global fish demand and supply: perspective from a short-term projection model". The WAPI template automatizes the generation of charts which can be easily updated or modified—with a few mouse clicks to update or redo the chart for different species, time horizons, and geographic focus. Thus, WAPI can significantly facilitate the analytical research process of examining future fish demand and supply at the national (nearly 200 countries), regional (about 40 country groups) and global levels for 9 species groups. The WAPI templates can be further refined by users into custom-designed templates for specific research applications.

Four interns at FAO have contributed to the development of WAPI modules and to the preparation of the corresponding background documents. Their experiences indicate that WAPI could become an educational tool to help students acquire knowledge and information and improve their skills on data analysis. After about six months of intensive, learning-by-doing process of WAPI development, all the interns have acquired or improved skills in using spreadsheet and statistical software (e.g. STATA) for data analysis and presentation. Participation in preparing the background documents has also enhanced their analytical skills.

FAO would continue to explore the potential of WAPI as a research and educational tool and welcome the participation and collaboration of researchers and students[4] in the development of WAPI templates.

Comments on WAPI initiative can be sent to: **WAPI@fao.org.**



This chart illustrates and compares the status (represented by the X-axis) and trends (represented by the Y-axis) of per capita fish consumption in different continents.

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1 Details about WAPI can be found in the Report of the FAO Expert Workshop on Assessment and Monitoring of Aquaculture Sector Performance (www.fao.org/documents/card/en/c/ec92bf28-52c4-5f0f-8489-397b41ee223b)

2 These papers, include "Assessment and Monitoring of Global Fish Demand and Supply: Perspective from A Short-Term Projection Model", "Assessment and Monitoring of the Contribution of Aquaculture and Fisheries to GDP", "Assessment and Monitoring of Species Diversification in Global Aquaculture", "Assessment and Monitoring of Global Tilapia Markets" and "Assessment and Monitoring of Human Resource and Employment in Aquaculture and Fisheries: A Case Study on China".

3 More details about WAPI can be found in the article "World Aquaculture Performance Indicators (WAPI): a user friendly tool" published in an early issue of FAN (issue 41, June 2013), available at www.fao.org/docrep/018/i2959e/i2959e.pdf.

4 See a WAPI internship announcement at www.fao.org/fishery/nems/40889/en

FAO Assists a Group of French Small-Scale Fishermen During a Visit to Orbetello Lagoon, Italy

In the Mediterranean Sea, coastal lagoons are facing environmental issues mainly due to increased industrial and human activities, which affect water quality and have an impact in the environment, leading overexploitation of fishery resources. During the past 10 years these phenomena have produced an important decrease in the number of small-scale fishermen which cannot afford the fall in their daily catches. Consequently, some are abandoning the activity and others are looking into alternative options such as aquaculture and better marketing strategies of lagoon products allowing them to survive and keeping alive historical fishing traditions.

Fishing operations in the Orbetello lagoon

Within this context, FAO supports fisherman to fisherman exchanges for strengthening collaboration between fishing communities with the aim of improving management of lagoon resources through the application of principles of good practices for fisheries and aquaculture.

With the assistance of FAO, on 9 and 10 January 2017 a group of fishermen from Thau coastal lagoon in Sète, France, visited the Italian fishermen of the "Cooperativa di pescatori di Orbetello" (Fishermen Cooperative of Orbetello) in the lagoon of Orbetello located in Tuscany, at 130 kilometers north of Rome, Italy.

In the Lagoon of Orbetello fishing has a long history and it represents the main activity for local economy along with tourism. European seabass (*Dicentrarchus labrax*), gilthead seabream (*Sparus aurata*), mullet (*Mugil* spp.) and European eel (*Anguilla anguilla*) are among the most common

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▶▶ FAO Assists a Group of French Small-Scale Fishermen During a Visit to Orbetello Lagoon, Italy

species found in this coastal environment. Local fishermen have always used traditional fishing methods such as fixed traps, fyke nets, longlines and trammel nets to catch these species. These methods exploit life cycle of targeted species that use to move into the lagoon for on-growing: fish, in fact, spontaneously enter the lagoon according to the season and the tides, without the use of bait feed.

Mechanized fishing gears ("lavorieri" in Italian), positioned in correspondence of the channels that allow the exchange of water between the lagoon and open sea. With high tide, the entry of water from the sea into the lagoon attracts schools of fish toward the channels where "lavorieri" are positioned and divided in a series of rooms that lead fish to a capture area, where live fish is selected by species and by size.

The lagoon is used as a semi-natural environment where fishing activity and aquaculture are regulated by the main stakeholders which are the fishermen of the cooperative. Catches are sold fresh on demand or processed (e.g. fillets, "bottarga", smoked). In summer (June to September) during touristic season, lagoon products are served and sold at the restaurant of the Cooperative of Orbetello. In the lagoon, the Cooperative also owns an aquaculture facility used for on-growing seabream and seabass used for restocking and marketing.

This lagoon, although smaller than Thau lagoon, is considered a good model of integrated coastal management, capable to combine fisheries and aquaculture traditions, marketing activities for products from the lagoon and tourism, with particular attention to the environment. This visit allowed French fishermen to learn more about production systems used in the lagoon as well as management and marketing strategies applied to resources of the lagoon.

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Mechanized fishing gears "lavorieri" used in the Orbetello lagoon

Face to face meetings held during the two-day visit to Italy made possible to launch the idea of establishing a formal partnership between the two lagoons, Thau and Orbetello. This will allow closer collaboration between the two fishing communities, better exchange of fishing experiences and better management of the resources of the lagoon through the application of the principles of good practices in fisheries and aquaculture.

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Fish harvesting from the mechanized gear ("lavorieri")

©FAO/V. CRESPI

Transfer of gilthead seabream fingerlings from the nursery to the on-growing ponds

SEE ALSO

Website of the Fishermen Cooperative of Orbetello (In Italian only) **www.ipescatoriorbetello.it**

Cataudella S., Crosetti D., Massa F. (eds). Mediterranean coastal lagoons: sustainable management and interactions among aquaculture, capture fisheries and the environment. Studies and Reviews. General Fisheries Commission for the Mediterranean. No 95. Rome, FAO. 2015. 278 pp. **www.fao.org/3/a-i4668e.pdf**

The Real Secret of the Templars: Farmed Fish as the Basis for a Long Life[1]

Average consumption of fish and fishery products has grown to reach 20 kg per capita, driven by rising consumer awareness of the need for healthy diets and growing knowledge about the nutritional qualities of seafood. The article provides evidence that also in Medieval times such knowledge was present in certain communities, including the Knights Templar and that aquaculture was promoted as a source of regular supply of fish.

As shown by FAO statistics, average global seafood[2] fish consumption per capita has been increasing over the years to reach a new record of 20 kg/capita in 2014 (FAO, 2016). And FAO projections indicate that this is foreseen to grow further over the next decades as higher purchasing power and continuing urbanization increase consumers' appetite and access to fish and fishery products. The benefits from regular fish consumption and the importance of fish as an integral part of a balanced and nutritious diet are being recognized not only by middle-class consumers, but by governments and policymakers in both developed and developing countries wishing to promote seafood consumption as a way to achieve important health benefits to society. This has particular policy implications for aquaculture which is the main source of supply for the future growth in global demand.

Given the intense current focus on healthy living and the vast scientific evidence generated over the last few decades, it may come as a surprise to discover that also earlier generations had notions about some foods being healthier than others, and that the consumption of some food items or categories could be less safe than others. For example, we know that many religions have prohibitions on certain foods, or from certain species, and that some of these may have an origin in local practice and inspired by food safety concerns.

Religious communities, brotherhoods and orders would develop what we today would call guidelines and standards but were then and are still known as rules or *regola*. One recent editorial in Digestive and Liver Disease[3] addresses how the members of the Order of the Temple, the Knights Templar, implemented a fairly strict dietary regime prescribing regular consumption of fish and vegetables. Meat consumption was limited to three times a week and wine to be enjoyed in moderate quantities. Likewise, regular consumption of cheese, olive oil and fresh food was encouraged. Washing of hands before meals was mandatory and members engaged in manual work outside were exempted from the preparation or serving food. These rules were contained in the precepts of Bernard of Clairvaux and followed by the Knights Templar throughout their existence from the founding around 1119 until the order was dissolved in 1312.

The importance given to fish as a substitute for meat is noteworthy. At the time, and in fact until quite recently, meat was often considered a high status food, and certainly the one preferred by the higher social classes from which the noble Knights were recruited.

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1 This article is dedicated to the memory of Count Massimo Langosco di Langosco, 1943-2016, whose enthusiasm provided the necessary stimulus for proposing the topic to the editor.

2 Seafood is here to be understood as a generic term for fish and fishery products.

3 Digestive and Liver Disease 46 (2014). Pp 577-578. The diet of Templar Knights: Their secret to longevity? Franceschi, Francesco; Bernabei, R. Malfertheiner, P.; Gasbarinni, G.; Published by Elsevier Ltd. On behalf of Editrice Gastroenterologica Italiana S.r.L.

COURTESY: WORLDFISH

It is well known that monks in Medieval Europe were early pioneers of aquaculture, especially of carp. The Templars were no exception and fish farming was encouraged as a source of regular fish supply.

The Templars became soon known for their influence through their international networks, their power and riches. This should ultimately also cause their demise and dissolution by the hand of King Philip IV of France. However, they also became famous for their discipline and rigour, and their longevity. Official documents of the Vatican testify that many of them lived far longer compared to other people at the time, except of course those who were executed at the suppression of the Order. At the time, such longevity would be attributed to a special divine gift; today science attributes it to rules prescribed by Bernard of Clairvaux with a balanced and nutritious diet, a large intake of fish, vegetables and fruit as well as strict hygienic precautions.

Although hard scientific evidence on the nutritional benefits of seafood consumption is only of recent date, anecdotal evidence and observations were present also in historic times. Aquaculture was promoted as a source of regular fish supply and observations are presented on the links between a healthy lifestyle and a long life in the 13th century.

SEE ALSO

FAO. 2016. *The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all.* Rome. 200 pp.
www.fao.org/3/a-i5555e.pdf

Arrivederci Jiansan Jia ("JJ")!

After almost 20 years with FAO Mr Jiansan Jia will be retiring as a full time FAO senior staff member. This brief article highlights his remarkable career and wishes him well on future activities.

On March 16, 1998, Mr Jiansan Jia took up duties as the Chief of the Inland Water Resources and Aquaculture Service (FIRI – currently FIAA) of the Fisheries Department at FAO Headquarters in Rome. Long time readers of FAN may remember the happy announcement in the April 1998 issue number 18 where Mr Jia's was introduced to the readership. That article listed Mr Jia's impressive accomplishments before coming to FAO: he was the Director of the External Economic Relations, in the Bureau of Aquatic Products in the Ministry of Agriculture in Beijing; he was then promoted to Deputy Director General of the Bureau of Aquatic Products; he then served as Vice General Manager of the China National Fisheries Cooperation; thereafter Mr Jia was first Deputy Director General and Director General ad interim of the Department of International Cooperation; just before coming to FAO he was appointed General Manager of the China National Agricultural Livestock/Fishery Corporation in Beijing.

As reported in that early FAN articles, Mr Jia was the first Chief of the FAO Inland Fisheries and Aquaculture Service (FIRI - currently FIAA) with predominately aquaculture experience. Once in FAO Mr Jia began a process of supporting aquaculture and consolidating aquaculture expertise within FIRI. This process brought economists and resource people together and greatly facilitated FIRI's work on aquaculture.

As this process was taking place, Mr Jia was recognized as a dedicated and caring service Chief. He became affectionately known as 'JJ'.

However, the friendly nickname did not slow down his efforts to bring aquaculture to its rightful place in the agenda of FAO. In fact, even the name of the service was changed to the Aquaculture Conservation and Management Service (FIMA - currently Aquaculture Branch, FIAA) and the name of the department became the Fisheries and *Aquaculture* (emphasis added) Department. This elevated status of aquaculture in FAO's efforts to improve food security and eliminate hunger were due in large part to JJ and the staff that he put together. JJ was instrumental in the establishment of the Sub-Committee on Aquaculture of the Committee on Fisheries and its inaugural session was held in 2001 in Beijing. He oversaw the convening of two global conferences on aquaculture that further demonstrated the important role aquaculture can play in improving food security and nutrition. Realizing that no one group or organization can develop and manage the aquaculture sub-sector on its own, he facilitated the development of the Aquaculture Network for Africa, the Network of Aquaculture of the Americas and the Network of Aquaculture Centres in Central Eastern Europe; cooperation between the Network of Aquaculture Centres in Asia-Pacific and the rest of the developing world was also enhanced.

As a result of his accomplishment and leadership qualities, in January 2014, JJ was promoted to Deputy Director of the Fisheries and Aquaculture Policy and Resources Division.

Many of us can thank JJ for many things, not only professionally, but personally as well. He is a great colleague and friend. Please join us in wishing him well in whatever activities he pursues after FAO. Hopefully he will still make himself available as a retiree consultant to the organization. We also hope he will continue with Chinese lunches, and the friendship and the collegiality that he showed to us all these past decades.

Arrivederci literally means 'to see us again' and we look forward to seeing JJ again.

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SEE ALSO

FAN 18 - **www.fao.org/docrep/005/w8516e/w8516e00.htm**

FAN 52 - **www.fao.org/3/f82ff154-b68c-48ec-a5d0-0b06f044d432/h0028e.pdf**

NEW STAFF PROFILES

Haydar Fersoy

Senior Fisheries and Aquaculture Officer, FAO Regional Office for Near East and North Africa, Cairo, Egypt

Prior to joining the FAO Regional Office for Near East and North Africa (RNE), Haydar, a Turkish National, was International Consultant at the FAO Sub regional Office for Central Asia between 2010 and 2016, where he undertook roles in the Central Asia Regional Programme for Fisheries and Aquaculture Development; Secretariat of the Central Asian and Caucasus Regional Fisheries and Aquaculture Commission (CACFish) and the European Inland Fisheries and Aquaculture Advisory Commission (EIFAAC). Previously he served the Turkish Ministry of Food, Agriculture and Livestock for 20 years. During his time at the Ministry, he worked primarily in the areas of aquaculture; fisheries research; multilateral and bilateral negotiations; fisheries planning, policy and management; legislative and regulatory approximation; fisheries conservation and biodiversity; Fisheries Monitoring, Control and Surveillance; and fish genetics and disease. As national delegate, he represented Turkey at a number of regional and international fora with a mandate in fisheries.

He holds a MSc (by research) degree in fish genetics from the Institute of Aquaculture, University of Stirling in Scotland, United Kingdom.

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Omar Elhassan

Volunteer, Aquaculture Branch

Omar, a US National, recently joined the Aquaculture Branch of the Fisheries and Aquaculture Department in Rome, Italy as a volunteer for six months. He recently completed his BSc in Environmental Soil Science from Texas A&M University in USA. In his studies, Omar specialized in water quality and his research investigated the effects of wastewater treatment plants on antibiotic resistance profiles in a local watershed. In 2014, Omar worked as a policy intern at the Southern Environmental Association (Belize), a marine conservation NGO, on mangrove restoration projects. During 2014-2017 Omar was Project Manager for Just4Water, a nonprofit coordinating sustainable water solutions in rural Central America and, from 2016-2017, also worked as a grant writer for The Center on Conflict and Development, a USAID Development Laboratory. After FAO, Omar will work as an Agroforestry Specialist in Senegal from 2018-2020.

At FAO, Omar will research the environmental impacts aquaculture-related AMU (Antimicrobial Usage) and AMR (Antimicrobial Resistance) under Dr Melba Reantaso supervision. Omar will be participating in the weekly AMR-working group and initiate a review of the literature on the environmental impacts of antimicrobials in aquaculture. He will also be presenting at Aquatic AMR Workshop in Mangalore, India.

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Omar.Elhassan@fao.org

Zhiyi Zhang

Intern, Aquaculture Branch

Zhang Zhiyi, a Chinese National. Zhiyi was recommended for joining master program as well as joining PhD program with exemption in Shanghai Ocean University in China. The major of her PhD is Fishery Economics & Management and she specializes in ecological compensation of aquaculture activities. And she got her Bachelor degree in Accounting in the same university. Before coming to FAO, Zhiyi applied as well as lead & finished The Shanghai Municipal Science and Technology Innovation Project for college student twice. And she also participated in a national level research program and two Shanghai municipal level research programs. As for awards, she is The Outstanding Graduate of Shanghai Ordinary University in 2014 and she got different scholarships many times.

During her 6 months internship in FAO, Zhiyi will carry out data compilation on Chinese fishery market access regulations and will translate some sections of the GLOBEFISH website into Chinese. She will also collaborate with the FAO Aquatic Genetic Resources team for data analysis and Ecosystem Approach to Aquaculture related research.

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Zhiyi.Zhang@fao.org

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Lionel Dabbadie

Consultant, Aquaculture Branch

Lionel a French National, is an Agronomist Engineer and he holds a Doctoral Degree from the University of Paris-6, France for his work on pond dynamics in Ivorian rural periphyton-based aquaculture ponds. As a scientist of French Cirad (Agriculture Research for Development Centre - www.cirad.fr/en), he has been working on long term assignments in Côte d'Ivoire, Guinea, Brazil, the Philippines, Thailand, and Madagascar, with an interest in understanding better aquaculture development and its interactions with surrounding human and natural environments. He has also worked on aquaculture networking and knowledge sharing, following his involvement in the SARNISSA (www.sarnissa.org) project and more recently, engaged himself in higher education. The Asian Institute of Technology bestowed upon him the title of "Distinguished Adjunct Faculty", and he recently coordinated an e-learning project for the French Virtual University on Environment and Development (UVED). Lionel joined FAO Aquaculture Branch in November 2016 to assist the Branch in regular program work as well as project supervision and backstopping.

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Xiao Liang

Volunteer, Aquaculture Branch

Xiao Liang, a Chinese National, has joined the Aquaculture Branch to work as a volunteer trade specialist for 6 months. Xiao is now employed by Agricultural Trade Promotion Center of Ministry of Agriculture in China since 2013, where her major role was to organize and facilitate agricultural trade expos such as China Potato Expo, the Seoul Food, etc. In 2014 and 2015, she was seconded to the Division of Asian and African Affairs, International Cooperation Department of Ministry of Agriculture as a program officer responsible for bilateral agriculture cooperation between China and Japan, Republic of Korea, Mongolia and Central Asian countries, as well as multilateral cooperation in the region. Xiao obtained her bachelor degree in trade and economics in 2010 and a master's degree in Economics in 2013 from the Capital University of Economics and Business (CUEB) in Beijing, China. She also has a master's degree in International Relations from Johns Hopkins-Nanjing Center.

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Pierre Murekezi

Consultant, Aquaculture Branch

Pierre a Rwandese National, holds a Master's Degree in Rule of Law Development from Loyola University Chicago, USA and a Bachelor's Degree in law from National University of Rwanda.

Prior to joining FAO, he worked in the Ministry of Agriculture and Animal Resource, Kigali, Rwanda as Policy Analysis Officer. During his time at the ministry, he was providing intellectual leadership, management and contributions to a range of policy research projects undertaken by the team, including supervision of project design, research methods, policy judgement and participation in report writing.

In 2013, he joined FAO Legal Office as legal consultant in charge of supporting legal databases (FAOLEX - www.fao.org/faolex/en, Portlex - www.fao.org/legal/databases/portlex/en) and the draft of legal documents (institutional matters, international environmental law).

During his assignment in the Aquaculture Branch, Pierre will be working on aquaculture policy and governance topics. Specifically, he will support FIAA's work on: (i) the assessment of opportunities and needs of national aquaculture platforms for promotion of public-private partnerships and best practices in aquaculture; (ii) drafting and/or analyzing legal documents related to the Aquaculture Network for Africa (ANAF); (iii) aquaculture governance in Africa; (iv) updating the National Aquaculture legislation Overviews (NALOs - www.fao.org/fishery/nalo/search/en).

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NEW PUBLICATIONS

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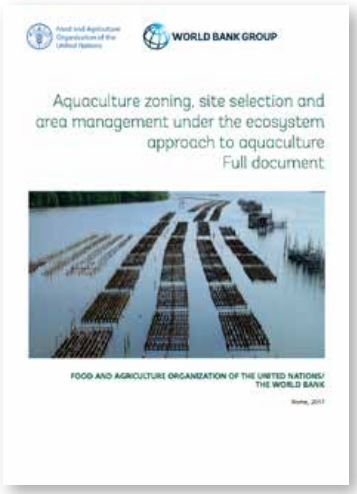
TECHNICAL PAPERS



FAO. 2017

Aquaculture zoning, site selection and area management under the ecosystem approach to aquaculture. A handbook

Report ACS18071. Rome, Italy, FAO, and World Bank Group, Washington, DC. 62 pp. *Includes a USB card containing the full document (395 pp.)*

The ecosystem approach to aquaculture provides the conceptual guideline for spatial planning and management. This publication describes the major steps related to these activities. The rationale for and objectives of each step, the ways (methodologies) to implement it, and the means (tools) that are available to enable a methodology are described in a stepwise fashion. Recommendations to practitioners and policy-makers are provided. A separate policy brief accompanies this paper. The benefits from spatial planning and management are numerous and include higher productivity and returns for investors, and more effective mitigation of environmental, economic and social risks, the details of which are provided in this paper.

This publication is organized in two parts. Part one is the "Guidance"; it is the main body of the document and describes the processes and steps for spatial planning, including aquaculture zoning, site selection and area management. Part two of the publication includes six annexes that present key topics, including: (i) binding and non-legally binding international instruments, which set the context for sustainable national aquaculture; (ii) biosecurity zoning; (iii) aquaculture certification and zonal management; (iv) an overview of key tools and models that can be used to facilitate and inform the spatial planning process; (v) case studies from ten countries – Brazil, Chile, China, Indonesia, Mexico, Oman, the Philippines, Turkey, Uganda and the United Kingdom of Great Britain and Northern Ireland; and (vi) a workshop report.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6992e.pdf

For further information, please contact: **Jose.AguilarManjarrez@fao.org**

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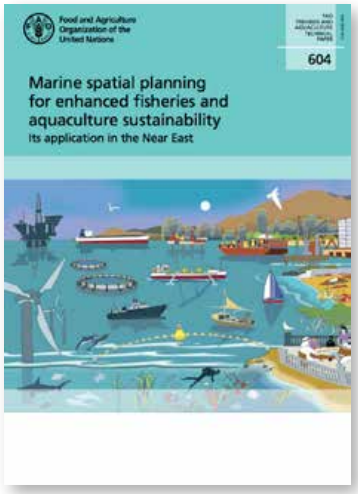

FAO. 2016

Marine spatial planning for enhanced fisheries and aquaculture sustainability – its application in the Near East

Meaden, G.J., Aguilar-Manjarrez, J., Corner, R.A., O'Hagan, A.M. & Cardia, F. FAO Fisheries and Aquaculture Technical Paper No. 604. Rome, Italy

This document provides a clear and comprehensive account for the application of marine spatial planning (MSP) within the Regional Commission for Fisheries (RECOFI) region. It builds on regional technical workshops, held under the auspices of the Food and Agriculture Organization of the United Nations (FAO), aimed principally at improving the prospects for fisheries and aquaculture in the Near East.

Marine spatial planning provides a step-by-step process that allows for the cooperative integration of the major marine uses and users within a defined marine area. These ordered procedures allow all stakeholders to work towards ensuring the long-term sustainability of identified marine activities.

The principles of the ecosystem approach to both fisheries and aquaculture can readily be incorporated into the process. The output of MSP is the development of a plan that addresses any potentially conflicting uses of the sea, thus enabling the strategic, forward-looking planning for the regulation, zoning, management, protection and sustainability of the marine environment. MSP can best function if it includes continuing reinforcement and adjustments of learned experiences over a long time period. The document concludes by providing three annexes. The first includes the main recommendations concerning the adoption of marine spatial planning taken from the RECOFI (FAO) Cairo workshop in 2012. The second describes the main marine activities to be included in marine spatial planning for Saudi Arabia. The third annex provides a comprehensive listing of additional information about MSP, including worldwide examples where MSP has been applied under varied local conditions at highly variable geographic scales.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6043e.pdf

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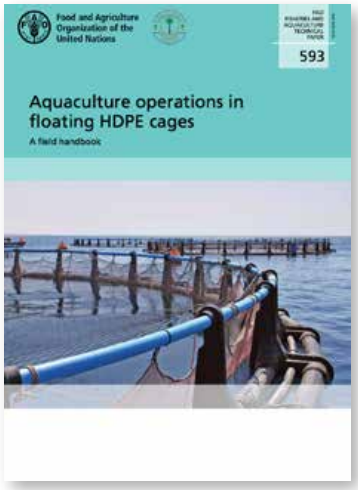

FAO. 2015

Aquaculture operations in floating HDPE cages: a field handbook

Cardia F. & Lovatelli A. 2015. FAO Fisheries and Aquaculture Technical Paper. No. 593. Rome, FAO

Cage aquaculture has grown rapidly in recent decades, and there has been a move towards the development and use of more intensive cage-farming systems to access and expand into untapped open-water areas, particularly in marine offshore waters. Fish cages vary in design, size and materials used, as they have been designed for employment in diverse environments, ranging from relatively protected to highly exposed and dynamic sites, either as floating or fully submerged structures. This technical manual focuses on high-density polyethylene (HDPE) cages as they are widely used in modern industrial marine aquaculture in many parts of the world. It provides the reader with highly practical and technical information on the design and components of a typical HDPE cage, and on how a cage collar is assembled and the net pen installed. Along with the structure of the cage, comprehensive information on the grid mooring system and installation is provided. Finally, the manual presents and discusses information on farming operations, including maintenance and control of the farming structures, stocking of the farmed fish, feeding, harvesting and packaging as well as other practical aspects and routine management operations.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i4508e.pdf (English)

www.fao.org/3/b-i4508a.pdf (Arabic)

For further information, please contact: **Alessandro.Lovatelli@fao.org**

FAO AQUACULTURE REGIONAL REVIEWS

FAO. 2016

Regional Review on Status and Trends in Aquaculture Development in Asia-Pacific – 2015

Rohana Subasinghe. FAO Fisheries and Aquaculture Circular No. 1135/5. Rome, Italy

Thirty-five countries produced more farmed than wild-caught fish in 2014 and four top producers in Asia-Pacific, namely, Bangladesh, China, India and Viet Nam are included in this group. Historically, the Asia-Pacific region (in particular China, South Asia and South-East Asia sub-regions) has dominated global aquaculture production, both in quantity and value; the region contributed 65.2 million tonnes of aquatic animals, amounting to 88 percent of the global total in 2014. The value of Asia-Pacific regional aquatic animal production in 2014 was 79 percent of the global total, amounting to US$127 billion.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6875e.pdf

For further information, please contact: **Maclom.Beveridge@fao.org**

FAO. 2017

Regional review on status and trends in aquaculture development in Europe – 2015,

Roy Clarke and John Bostock. FAO Fisheries and Aquaculture Circular No. 1135/1. Rome, Italy

This update considers the wider European region comprising the 43 countries that were the object of the more detailed 2010 review of aquaculture in Europe (Váradi et al., 2011) and in particular notes significant changes related to aquaculture in that region since 2010. Aquaculture production data have been obtained from FAO Fisheries and Aquaculture Department. The most notable development in the period has been the continuing increase in the production of Atlantic salmon (by 43 percent for the period 2009–2014), mainly in the Kingdom of Norway but with significant increases also in the Faroe Islands, the United Kingdom of Great Britain and Northern Ireland and the Russian Federation.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6865e.pdf

For further information, please contact: **Maclom.Beveridge@fao.org**

FAO. 2017

Regional review on status and trends in aquaculture development in North America – 2015

Brian Harvey. FAO Fisheries and Aquaculture Circular No. 1135/2 Rome, Italy

The review summarizes status and trends of aquaculture development in North America for the period 2010–2015 and concentrates on activities in Canada and the United States of America. Relevant aspects of the social and economic background of each country are followed by a description of current and evolving aquaculture practices (species, methods, amounts and values) and the needs of the industry in terms of resources, services and technologies. Impacts of aquacultural practices on the environment are discussed, followed by a consideration of the industry's response to market demands and opportunities and its contribution to social and economic development at the regional, national and international levels.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6866e.pdf

For further information, please contact: **Maclom.Beveridge@fao.org**

FAO. 2017

Regional review on status and trends in aquaculture development in Latin America and the Caribbean – 2015

Carlos Wurmann G. FAO Fisheries and Aquaculture Circular No. 1135/3. Rome, Italy

With a land surface of 21 million square kilometers and a population of 634 million (2015), Latin America and the Caribbean (LAC) has drastically diminished its capture fish production, from 19.8 to 10.8 million tonnes between 2000 and 2014, as a result of decaying pelagic fisheries off Peru and Chile and a decline in catches in several coastal areas. In contrast, aquaculture evolved from 0.8 to 2.8 million tonnes and values from US$3.8 to US$15.9 billion in the same period. These facts have allowed aquaculture to increase its contribution to total regional landings from 4.1 percent in 2000 to 20.5 percent in 2014.The region also contributed 3.8 percent to world aquaculture production in volume but to a more substantial 10.7 percent in value terms, and 11.6 percent to total wild catches, in 2014. The region is second only to Oceania in the average value per kilogram of its farmed production.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6867e.pdf

For further information, please contact: **Maclom.Beveridge@fao.org**

FAO. 2017

Regional review on status and trends in aquaculture development in sub-Saharan Africa – 2015

Benedict P. Satia. FAO Fisheries and Aquaculture Circular No. 1135/4 Rome, Italy

The present regional review and synthesis for sub-Saharan Africa provides an overview of major issues and trends in the aquaculture sector between 2004 and 2014 with emphasis on outstanding issues over the last five years. The regional review reflects development in 41countries in SSA for which production was reported to FAO in 2014. The production volume and value data have been derived from the latest FAO global aquaculture dataset 1950–2014 (FishStat). Freshwater (inland), brackish water and marine (coastal) environments are used for aquaculture production, but most of the activities are concentrated inland. The operations, particularly inland, are either subsistence, small-scale market-driven or large industrial scale. Between 2004 and 2014 there was a seven-fold increase in production with an average percent growth rate (APR) of 21 percent.

The PDF version of this publication can be downloaded at the following web link:

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For further information, please contact: **Maclom.Beveridge@fao.org**

FAO. 2017

Regional review on status and trends in aquaculture development in the Near East and North Africa – 2015

Abdel-Fattah M. El-Sayed. FAO Fisheries and Aquaculture Circular No. 1135/6. Rome, Italy

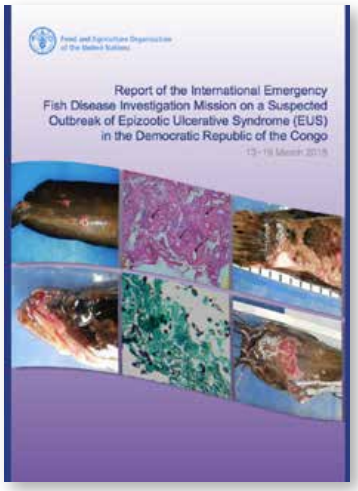
The Near East and North Africa (NENA) region comprises 20 countries with a total land area of about 12 million km^2. It is mostly desert and arid lands, with a total population of about 415 million people. All NENA countries have sea borders, but fresh water resources are very scarce. Except in the Arab Republic of Egypt and the Islamic Republic of Iran, the contribution of aquaculture to national gross domestic product (GDP) in the region is negligible. Aquaculture production in the NENA region has doubled over the past decade (2005–2014), from 702 340 tonnes in 2005 to 1 531 318 tonnes in 2014, with an average annual growth rate of 9.7 percent. However, Egypt and Iran contributed 74 and 21 percent, respectively, to total aquaculture output. Meanwhile, the role of aquaculture in total fish production is steadily increasing in the region.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6876e.pdf

For further information, please contact: **Maclom.Beveridge@fao.org**

WORKSHOP REPORTS



FAO. 2017

Report of the International Emergency Fish Disease Investigation Mission on a Suspected Outbreak of Epizootic Ulcerative Syndrome (EUS) in the Democratic Republic of Congo

Democratic Republic of Congo, 13–19 March 2015

In response to a request for an emergency technical assistance from the Government of the Democratic Republic of Congo (DRC) in connection with a serious disease affecting fish in Lokame River in Loko and in Mbanza Oton, 60 km from Gbadolite, FAO formed an International Emergency Disease Investigation Task Force. The overall objective of the Task Force was to (1) confirm that an outbreak was happening; establish a case definition and presumptive diagnosis of the causative agent; (2) collect and process fish samples for relevant laboratory tests; (3) identify risk factors, confirm diagnosis and define further investigation or follow-up work; (4) recommend border/cross border control measures to prevent further spread of the disease; (5) identify specific short-term and medium-term biosecurity action plans that the government may undertake; and (6) provide further recommendations to FAO on how to prevent the further spread of the disease. Some members of the Task Force travelled to DRC from 13 to 19 March 2015, conducted field investigations and laboratory test and has confirmed the presence of the epizootic ulcerative syndrome (EUS) using three recommended confirmatory tests such as: (i) demonstration of mycotic granulomas and fungal structures in stained histological sections, (ii) isolation of Aphanomyces invadans on culture media and (iii) positive identification by polymerase chain reaction (PCR) of A. invadans genomic DNA.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6596e.pdf

For further information, please contact: **Melba.Reantaso@fao.org**

FAO. 2017

Regional Conference "Blue Growth in the Mediterranean and the Black Sea: developing sustainable aquaculture for food security"

Massa, F., Rigillo, R., Bourdenet, D., Fezzardi, D., Nastasi, A., Rizzotti, H., Emam, W. & Carmignac, C. 9–11 December 2014, Bari, Italy. FAO Fisheries and Aquaculture Proceedings No. 46. Rome

The Regional Conference "Blue Growth in the Mediterranean and the Black Sea: developing sustainable aquaculture for food security" was organized by the General Fisheries Commission for the Mediterranean (GFCM) of the Food and Agriculture Organization of the United Nations (FAO) in collaboration with the Italian Presidency of the Council of the European Union, the Italian Ministry of Agriculture, Food and Forestry Policies (MiPAAF) and the European Commission and in partnership with the International Organisation for the Development of Fisheries in Central and Eastern Europe (Eurofish) and the International Union for Conservation of Nature (IUCN). This event took place at the International Centre for Advanced Mediterranean Agronomic Studies, Institute of Bari (CIHEAM Bari), Italy. The conference was attended by more than 140 representatives of governments and international organizations, delegates, experts and practitioners from 16 Mediterranean and Black Sea riparian countries, who exchanged their views on the most salient issues connected to sustainable aquaculture development in the region. The conference acknowledged the key role to be played by the sector in achieving food security, employment and economic development in the region, under a blue growth perspective. All participating countries reached a consensus on the need to foster cooperation and implement coherent and coordinated strategies to face challenges ahead and ensure the sustainable and responsible growth in the sector in the Mediterranean and the Black Sea. This event was also marked by the adoption of conclusions and recommendations, which laid the groundwork for the establishment of a GFCM Task Force on a Strategy for the sustainable development of Mediterranean and Black Sea aquaculture.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6902e.pdf (English and French)

For further information, please contact: **Dominique.Bourdenet@fao.org**

FAO. 2016

Report of the FAO workshop launching the Blue Growth Initiative and implementing an ecosystem approach to aquaculture in Kenya

Mombasa, Kenya, 27-31 July 2015. FAO Fisheries and Aquaculture Report No. 1145. Rome, Italy

The Blue Growth Initiative (BGI) is an FAO flagship initiative that aims at supporting more productive, responsible and sustainable fisheries and aquaculture sectors by improving the governance and management of the aquatic ecosystems, conservation of biodiversity and habitats, and empowering communities. Under the BGI umbrella, FAO, in collaboration with the Government of Kenya, is implementing two projects for the coast of Kenya. The objectives of these initiatives are to: (i) increase knowledge of water basin to coral reef ecosystem services supporting food, nutrition and livelihood security; (ii) identify the drivers of ecosystem services deterioration as well as the management options to improve them; and (iii) foster investment in coastal sustainable mariculture and promote its development under the ecosystem approach to aquaculture (EAA). This report describes the activities and outcomes of a workshop that took place in Mombasa, Kenya, from 27 to 31 July 2015. The objectives of the event were to: (i) launch the BGI in the country; and (ii) conduct a training session on the implementation of the EAA for the sustainable development of mariculture in Kenya by considering integration with other users of the coastal zones, such as tourism, fisheries and agriculture.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i5997e.pdf

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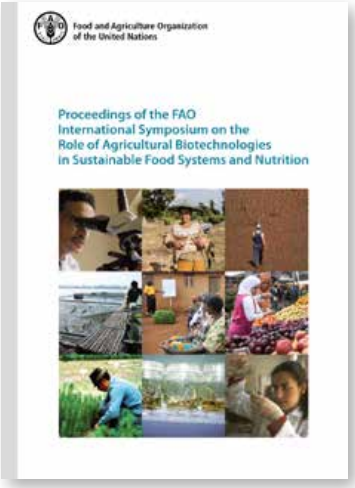

FAO. 2016

Proceedings of the FAO International Symposium on the Role of Agricultural Biotechnologies in Sustainable Food Systems and Nutrition

Edited by Ruane J., Dargie J.D. & C. Daly. 284 pp. FAO, Rome, Italy

The FAO international symposium on "The role of agricultural biotechnologies in sustainable food systems and nutrition" took place from 15 to 17 February 2016 at FAO headquarters, Rome. Over 400 people attended, including 230 delegates from 75 member countries and the European Union, as well as representatives of intergovernmental organizations, private sector entities, civil society organizations, academia/research organizations and producer organizations/cooperatives. The symposium encompassed the crop, livestock, forestry and fishery sectors and was organized around three main themes: i) climate change; ii) sustainable food systems and nutrition; and iii) people, policies, institutions and communities. The proceedings provide the main highlights of the symposium which covered a broad range of biotechnologies, from low-tech approaches such as those involving use of microbial fermentation processes, biofertilizers, biopesticides and artificial insemination, to high-tech approaches such as those involving advanced DNA-based methodologies and genetically modified organisms.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i5922e.pdf

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FAO. 2017

Report of the Sixth Aquaculture Network for Africa (ANAF) Annual Meeting, Entebbe, Uganda, 6 to 9 December 2016

FAO Fisheries and Aquaculture Report. No 1187. Rome, Italy

The purpose of the Sixth Annual Meeting of the Aquaculture Network for Africa (ANAF) was to reaffirm the commitment towards ANAF by its Member countries; discuss and agree on the draft of the four legal documents: (i) ANAF Founding Agreement, (ii) ANAF Rules of Procedure, (iii) ANAF Financial Regulations and (iv) ANAF Headquarters Agreement; and to discuss and agree on a clear strategy and concrete follow up actions leading to the establishment of ANAF as an Inter-Governmental Organization (IGO). During the meeting, two working groups were established. The ANAF legal documents were reviewed and endorsed. A Concept note on the roadmap for the establishment of ANAF was developed. Two options were proposed for establishment of ANAF: (1) ANAF secretariat to be hosted by a Member state as an IGO or (2) Integration of ANAF as a unit within AU-IBAR structure. The meeting was more in favour of the second option for budgetary reasons but a final decision will be taken by Member countries during the next Committee on Inland Fisheries and Aquaculture in Africa (CIFAA) Session to be held in Banjul, The Gambia, 9-11 May 2017. Mali offered to host the Seventh ANAF Annual meeting in 2017.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i7015e.pdf

For further information, please contact: **Valerio.Crespi@fao.org**

FAO. 2017

Report of the knowledge exchange on the promotion of efficient rice farming practices, Farmer Field School curriculum development, and value chains

Yogyakarta, Indonesia, 26–29 September 2016. FAO Fisheries and Aquaculture Report No. 1181. Rome, Italy

A total of 33 participants (10 women) participated in the Regional Rice Initiative – Workshop cum Study Tour on knowledge exchange on Farmer Field School curriculum development for promotion of efficient rice farming practices and value chains. Field visits were made to Sleman (Rice-Fish farming and "jajar legowo") and Boyalali (organic rice value chains) organized by FAO Indonesia in collaboration with the Ministry of Marine Affairs and Fisheries and the international civil society organization Vredeseilanden (VECO) and its local partner CSO Aliansi Petani Padi Organik Boyolali (APOLLI). Following the study tour, the regional workshop was held to: (1) facilitate the regional exchange of knowledge and experiences on sustainable intensification of rice production, including Rice-Fish farming systems and rice value chains; and (2) take stock of Farmer Field School curricula currently available, introduce the FFS Guidance Document and identify opportunities for strengthening of the FFS curricula.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6617e.pdf

For further information, please contact: **Matthias.Halwart@fao.org**

FAO. 2016

Aquaculture insurance in Viet Nam: Experiences from the pilot programme

Kim Anh Thi Nguyen and Tipparat Pongthanapanich. FAO Fisheries and Aquaculture Circular No. 1133. Rome, Italy

This paper describes the experiences in aquaculture insurance in Viet Nam. The study focused on the first pilot phase of the national agricultural insurance programme coordinated by the Ministry of Finance and Ministry of Agriculture and Rural Development during 2011–2013. The programme was mandated by Decision No. 315/QD-TTg of the Prime Minister dated 1 March 2011. The programme covered rice farming, livestock husbandry and aquaculture. The Government subsidized the insurance premiums by applying four levels of entitlement according to the level of participants' household income: 100 percent to poor households, 80 percent to near-poor households (later increased to 90 percent), 60 percent to non-poor households, and 20 percent to organizations or cooperatives. Participating in the entire programme was 304 017 households and one agricultural organization. Poor households accounted for 77 percent.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6559e.pdf

For further information, please contact: **Tipparat.Pongthanapanich@fao.org**

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FAO. 2017

Report of the workshop on development of aquaculture insurance system for small-scale farmers

Bangkok, Thailand, 20–21 September 2016. FAO Fisheries and Aquaculture Report No. 1177. Rome, Italy

The workshop aimed to identify policy and technical measures that would make insurance available and accessible to small-scale aquaculture farmers. Three commissioned papers and seven supplementary papers and presentations informed the discussions, which led to a set of recommendations addressed to the participating countries as well as to other developing countries and a specific follow-up activity in Thailand with a possible FAO collaborative assistance. The participants were experts from China, the Philippines, Singapore, Thailand and Viet Nam. The second workshop, on 21 September 2016, focused on the prospects of a viable and sustainable aquaculture insurance for the shrimp aquaculture industry of Thailand. The deliberations were informed by a field study of the demand for insurance by the sector. It was joined by officers and members of shrimp farmers' cooperatives from five provinces of Thailand and the participants of the first workshop.

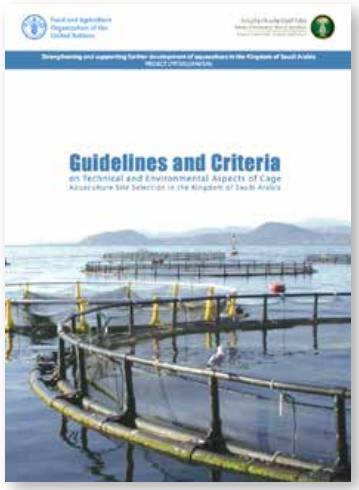
The workshop attained its objectives. It also facilitated these results: (i) made farmers, farmer advisers, researchers and academics more familiar with the insurance business and technical requirements of insurers, (ii) made insurers become more familiar with the circumstances and the needs of aquaculture farmers, (iii) confirmed that insurers continue to view aquaculture as a high-risk industry, (iv) highlighted the need to incorporate risk assessment and management in the development of better farm management practices in line with the requirements of insurance, and (v) confirmed the usefulness of bundling credit and insurance in the development of institutional services for farmers.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6823e.pdf

For further information, please contact: **Tipparat.Pongthanapanich@fao.org**

PROJECT REPORTS



FAO. 2017

Guidelines and Criteria on Technical and Environmental Aspects of Cage Aquaculture Site Selection in the Kingdom of Saudi Arabia (publication of the UTF/SAU/048/SAU project)

Cardia F., Ciattaglia A. & Corner R.A.

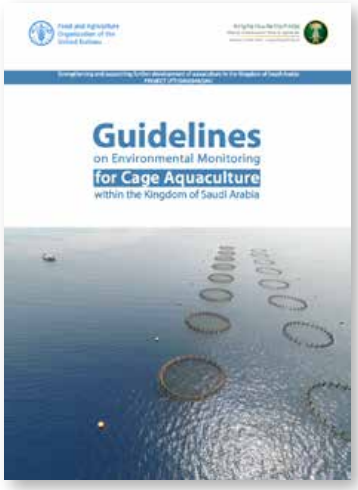
Siting is a critical step in the planning phase of new cage aquaculture projects. In the screening of the possible sites where a cage farm can be installed, it is critical to assess interactions and potential conflicts with the surrounding environment and with other coastal users. Saudi Red Sea coast is experiencing large development activities, and the proper selection process of suitable sites is the key factor to ensure success and sustainability of any commercial cage operation. This publication provides a wide information on the most relevant criteria that need to be taken into consideration when going throughout the siting process for cage aquaculture projects.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6719e.pdf (English)

www.fao.org/3/a-i6719a.pdf (Arabic)

For further information, please contact: **Francescocardia67@gmail.com**



FAO. 2017

Guidelines on Environmental Monitoring for Cage Aquaculture within the Kingdom of Saudi Arabia (publication of the UTF/SAU/048/SAU project)

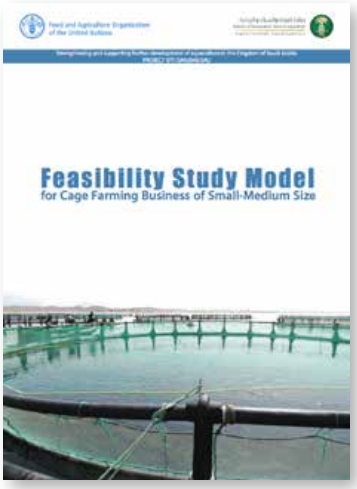
Corner R.A.

This document has been prepared based on sound scientific principles and international approaches to monitoring cage aquaculture facilities. In general this is a guide to help support good monitoring practice, with details on what to monitor, parameters to be collected, how data is collected, appropriate ways to process the data and what to do with it once the survey is complete and results available. Such monitoring activity will ensure that cage farms use practices that minimize environmental impacts for the long term sustainability of cage aquaculture within the Kingdom of Saudi Arabia. In this sense the document is for fish farmers and their consultants to ensure a unified process of monitoring using standardized procedures, but is more generally applicable for all stakeholders

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6863e.pdf

For further information, please contact: **Francescocardia67@gmail.com**



FAO. 2017

Feasibility Study Model for Cage Farming Business of Small-Medium Size (publication of the UTF/SAU/048/SAU project)

Ciattaglia, A.

The topics outlined in the feasibility study model are designed for the development of a technical project and business plan of small to medium fish farm projects. This tool has been designed to be used in the cage aquaculture licensing process in Saudi Arabia, providing guidelines to regulators on the format and the standard information scheme to be provided by investors when applying for cage aquaculture licenses. The book is in double language and it is provided with softcopies of excel spreadsheets where forms and business model are included to support private investors in developing the technical and economic feasibility study for a small- medium cage aquaculture project. The software allows the drafting of the business plan returning information on breakeven point, cash flow and loan scheme.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-i6718b.pdf

For further information, please contact: **Francescocardia67@gmail.com**

FAO. 2016

Atlas of potential areas for cage aquaculture Red Sea - Kingdom Of Saudi Arabia (publication of the UTF/SAU/048/SAU project)

Saunders, J., Cardia, F., Hazzaa, M.S., Rasem., B.M., Othaibi, M.I. & Rafiq, M.B

The Atlas of potential areas for cage aquaculture in the Red Sea has been funded, produced and published in a double language book within the framework of the Technical Cooperation Programme between the Kingdom of Saudi Arabia (KSA) and the Food and Agriculture Organization of the United Nations (FAO) during the implementation of the unilateral trust fund project "Strengthening and supporting further development of aquaculture in the Kingdom of Saudi Arabia (UTF/SAU/048/SAU)". The Atlas has been developed by the Geographic Information System unit in the Jeddah Fisheries Research Center under the guidance of Mr Justin Saunders, GIS expert and Francesco Cardia, Project Manager of the UTF/SAU/048/ SAU project. A number of datasets containing environmental and socioeconomic information useful for site selection have been developed and gathered in a GIS database; the most relevant site selection criteria have been then applied in the GIS analysis identifying promising areas for cage aquaculture development. 36 maps, covering the whole Red Sea coast of the KSA at a scale of 1:200 000, display the result of the analysis. In general, this is a marine spatial planning tool to support the identification of Aquaculture Management Areas, through the provision of geo-referenced information on some of the main criteria that may allow a proper siting of the cage farms, supporting the Ministry of Agriculture in the planning of the allocation of areas for cage aquaculture development and the investors who wish to establish marine cage aquaculture projects in the Red Sea.

The PDF version of this publication can be downloaded at the following web link:

www.fao.org/3/a-c0046b.pdf

For further information, please contact: **Francescocardia67@gmail.com**

CALENDAR OF EVENTS

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MARCH 2017

Regional Consultation on Responsible Production and Use of Feed and Feed Ingredients for Sustainable Growth of Aquaculture in Asia-Pacific
Bangkok, Thailand, 7-9 March 2017
Information: Weimin.Miao@fao.org

Terminal workshop on: Enhancing Aquaculture Production for Food Security and Rural Development Through Improved Feed Value Chain, Production and Use (TCP/KYR/3502)
Bishkek, Kyrgyzstan, 23rd March 2017
Information: Mohammad.Hasan@fao.org

Strengthening Biosecurity Capacity of Palau: Training Course on Biosecurity Database Development (TCP/PLW/3601/C1)
24-27 March 2017, Koror, Palau
Information: Melba.Reantaso@fao.org

Strengthening Biosecurity Capacity of Palau: National Workshop (TCP/PLW/3601/C1)
28 March 2017, Koror, Palau
Information: Melba.Reantaso@fao.org

Tenth Session of the Scientific Advisory Committee on Aquaculture (CAQ) of the General Fisheries Commission for the Mediterranean
Izmir, Turkey, 27-29 March 2017
Information: Fabio.Massa@fao.org

APRIL 2017

Driving African Fisheries to sustained Growth Conference, Build on the Achievements of the SmartFish Programme
Nairobi, Kenya, 3-6 April 2017
Information: Clotilde.Bodiguel@fao.org

FAO Write-Shop Part 2: Responsible Management of Bacterial Diseases in Aquaculture
6-8 April 2017, Mangalore, India
Information: Melba.Reantaso@fao.org

APRIL 2017

Strengthening Capacities, Policies and National Action Plans on Prudent and Responsible Use of Antimicrobials in Fisheries: Workshop 1 (FMM/RAS/298/MUL):
10-12 April 2017, Mangalore, India
Information: Melba.Reantaso@fao.org

Stakeholder's Inception Workshop on Fish Loss and Waste in Egypt,
Alexandria, Egypt, 11-12 April 2017
Information: Paula.Anton@fao.org

Inception Workshop on: Restarting and Modernization of Fish Seed Production in Tajikistan (TCP/TAJ/3601/C1)
25-26 April 2017, Dushanbe, Tajikistan
Information: Mohammad.Hasan@fao.org

MAY 2017

Strengthening Biosecurity Governance And Capacities for Dealing with the Serious Shrimp Infectious Myonecrosis Virus (IMNV) Disease: Second Inter-Regional Workshop (TCP/INT/3501):
2-5 May 2017, Natal, Brasil
Information: Melba.Reantaso@fao.org

Seventeenth Session of the Committee for Inland Fisheries and Aquaculture of Africa (CIFAA).
Banjul, the Gambia, 9-11 May 2017
Information: Ndiaga.Gueye@fao.org

Tenth Session of the Regional Commission for Fisheries (RECOFI)
Kuwait, Kuwait, 9-11 May 2017
Information: Haydar.Fersoy@fao.org

AUGUST 2017

Strengthening Capacities, Policies and National Action Plans on Prudent and Responsible Use of Antimicrobialsin Fisheries: Workshop 2 (FMM/RAS/298/MUL)
1-4 August 2017
Information: Melba.Reantaso@fao.org

SEPTEMBER 2017

Strengthening Biosecurity Governance and Capacities for Dealing with the Serious Shrimp Infectious Myonecrosis Virus (IMNV) disease: Third Inter-Regional Workshop (TCP/INT/3501)
4-7 September 2017, Bali, Indonesia
Information: Melba.Reantaso@fao.org

Sixteenth Session of the Committee on Fisheries (COFI) Sub-Committee on Fish Trade
Busan, Republic of Korea, 4-8 September 2017
Information: Audun.Lem@fao.org

OCTOBER 2017

Ninth Session of the Committee on Fisheries (COFI) Sub-Committee on Aquaculture
Tehran, Islamic Republic of Iran, 23-26 October 2017
Information: Matthias.Halwart@fao.org

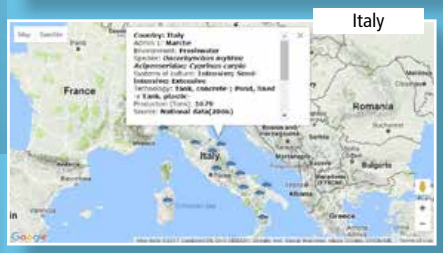
NON FAO EVENTS

Boston Seafood Show
United States of America, 19-21 March, 2017
Information: Audun.Lem@fao.org

National Aquaculture Sector Overview (NASO) Map collection

Examples of aquaculture inventories in selected countries

Subnational level

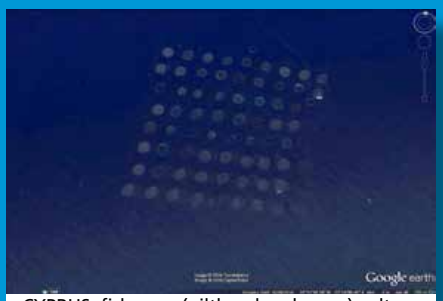


The collection consists of Google maps showing the location of aquaculture sites and their characteristics at an administrative level and at an individual farm level

Individual farm level

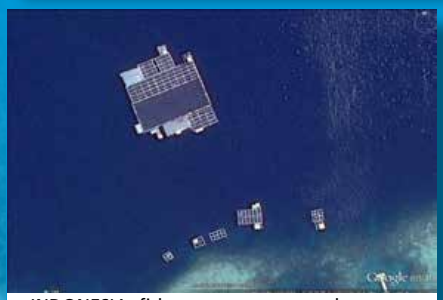
ANGOLA, intensive tilapia pond culture
S8°45'32.90"; E13°26'57.44"

COSTA RICA, semi-intensive tilapia pond culture
N10°22'15.56"; W84°21'21.06"



CYPRUS, fish cage (gilthead seabream) culture
N34°41'50.53"; E33°16'8.74"

GREECE, fish cage (gilthead seabream) culture
N34°41'50.53"; E33°16'8.74"



INDONESIA, fish cages, emperor red snapper
S5°39'39.41"; E105°13'23.98"

MALTA, fish cage (gilthead seabream) culture
N 35°49'38.86"; E14°32'30.97"

NICARAGUA, semi-intensive shrimp pond culture
N12°56'25.54" W87°28'58.94"

OMAN, shrimp farm,
N20°20'24.238"; E57°57'4.73"

UNITED ARAB EMIRATES, pond; hatchery (gilthead seabream) N24°28'45.23"; E54°28'44.82"

www.fao.org/fishery/naso-maps/naso-home/en

FAN

FAO Aquaculture Newsletter

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